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DIALOG(R)File 351:Derwent WPI

009582465 **Image available**
WPI Acc No: 1993-276011/199335
XRPX Acc No: N93-212119
Electron beam patterning method for semiconductor device - modifying at least one of deflection, shape or focus of electron beam when detected alignment data mark is outside tolerance range NoAbstract
Patent Assignee: HITACHI LTD (HITA)
Number of Countries: 001 Number of Patents: 001
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
JP 5190435	A	19930730	JP 926199	A	19920117	199335	B

Priority Applications (No Type Date): JP 926199 A 19920117
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
JP 5190435	A		13	H01L-021/027	

Abstract (Basic): JP 5190435 A
Dwg.1/15
Title Terms: ELECTRON; BEAM; PATTERN; METHOD; SEMICONDUCTOR; DEVICE; MODIFIED; ONE; DEFLECT; SHAPE; FOCUS; ELECTRON; BEAM; DETECT; ALIGN; DATA ; MARK; TOLERANCE; RANGE; NOABSTRACT
Derwent Class: U11; V05
International Patent Class (Main): H01L-021/027
International Patent Class (Additional): G06F-015/62; H01L-021/68
File Segment: EPI

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（A）　(11)特許出願公開番号

特開平5－190435

(43)公開日　平成５年(1993)７月30日

(51)Int.Cl.⁵	識別記号	庁内整理番号	F I		技術表示箇所
Ｈ０１Ｌ　21/027					
Ｇ０６Ｆ　15/62	３８０	9287－5L			
Ｈ０１Ｌ　21/68	Ｆ	8418－4M			
		8831－4M	Ｈ０１Ｌ　21／30	３４１　Ｋ	
		8831－4M		３４１　Ｍ	

審査請求　未請求　請求項の数４（全 15 頁）

(21)出願番号　特願平4－6199

(22)出願日　平成４年(1992)１月17日

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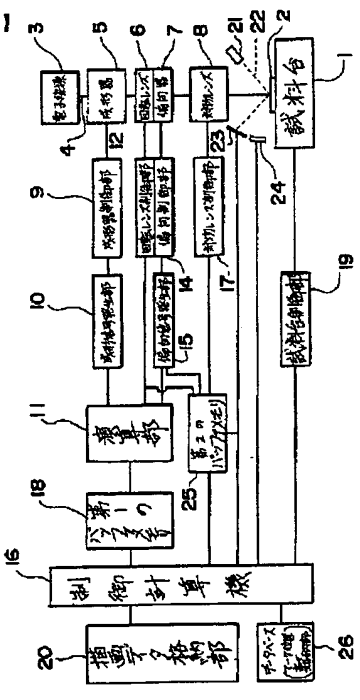
(54)【発明の名称】　半導体装置の電子線描画方法

(57)【要約】

【目的】　ウェハ上の欠陥、異物並びにウェハの歪の有無に拘らず精度の高い描画を可能とする描画方法、及び、描画処理と位置のズレに対する較正処理とを効率良く行う描画方法を提供する。

【構成】　ウェハ２表面の位置合わせマークＫｉを電子線４にて走査して位置／高さを検出し、そのデータを、データ検出時点でのウェハの種類，製造段階，及び面内分布に応じて予め分類されている記憶値と比較し、該データが、記憶値の分布の許容範囲から外れているときに、これに代えて対応する上記記憶値を読み出し、これを用いて電子線の偏向量／光電子面の形状／電子線の焦点位置を、偏向器７，回転レンズ６，対物レンズ８の制御により修正する。１回の電子線照射処理により描画される領域は、試料台１の移動方向と直交する方向の電子線走査幅に基いて決定され、該領域の描画終了毎にマークＫｉの検出による較正処理が行われる。

【図１】



【特許請求の範囲】

【請求項１】　半導体ウェハ表面を電子線にて走査して該ウェハ上に形成された複数の位置合せマークの位置又はウェハ表面の高さの少なくとも一方を検出し、斯く検出したデータを、データ検出時点でのウェハ状態に応じて予め分類された記憶値又は面内分布の少なくとも一方に応じて予め分類された記憶値と比較し、該検出したデータが記憶されたデータの分布の許容範囲から外れていると判断されたときに、これに対応する上記記憶値を読み出し、該外れたデータに代えてこの記憶値を用いて電子線の偏向量、電子線の光電子面の形状及び電子線の焦点位置の少なくとも１つを修正してウェハ表面に塗布されたレジストを感光することを特徴とする電子線描画方法。

【請求項２】　ウェハを搭載するＸ－Ｙステージを一方向に移動させながら該ウェハに電子線を当ててウェハ上に塗布されたレジストを露光する電子線描画方法において、ウェハの露光領域を、試料台の移動方向にこれと直交する方向の電子線走査幅に基いて複数の露光領域に分割し、該分割した露光領域の１つの領域に対する露光処理の終了毎に、ウェハ表面に形成された位置合せマークの位置又は高さの少なくとも一方を検出し、この検出結果に基いて位置合わせのずれに対する修正を行なうことを特徴とする電子線描画方法。

【請求項３】　ウェハを搭載するＸ－Ｙステージの連続移動方向と、ウェハ上に形成されるパターンの座標軸との回転誤差を計測し、該回転誤差に基いて電子線の偏向量の修正又は電子線の光電子面の形状の回転角度修正の少なくとも一方を行うことを特徴とすることを特徴とする電子線描画方法。

【請求項４】　電子線の偏向制御と、表面にレジストが塗布されたウェハが搭載されるＸ－ＹステージのＸ方向又はＹ方向の少なくとも一方へのステップ移動とを組み合わせてウェハ表面に所望のパターンを露光する電子線描画方法において、所定の基準点を中心とした電子線の偏向照射により描画可能な範囲より小さい描画領域を形成し、この描画領域に少なくとも２以上の描画基準点を形成し、この２以上の描画基準点に上記所定の基準点を順次合わせて同一パターンに対し２以上の電子線露光処理を行うようにしたことを特徴とする電子線描画方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、半導体製造技術さらには電子線を用いた微細加工技術に適用して特に有効な技術に関し、例えば、表面にレジストが塗布されたウェハに回路パターン等を転写する技術に利用して有用な技術に関する。

【０００２】

【従来の技術】半導体集積回路装置の製造工程において、レジストが塗布されたウェハに所望の集積回路パターンを転写する露光工程を行うに当り、電子ビーム（電子線）により該レジストを感光させる電子線露光技術が公知である（例えば株式会社工業調査会、昭和６１年１１月１８日発行、「電子材料」１９８６年１１月号別冊第１１０頁～第１１４頁）。この電子線露光技術では、レジストを塗布したウェハ表面に電子線を照射して集積回路パターンを直接描画するため、従来の光露光技術（一旦フォトマスクに集積回路パターンを形成し、これをウェハ上に転写する技術）よりも微細な集積回路パターンが形成できる。

【０００３】従って電子線による微細な集積回路パターンの描画を実効あらしめるためには、電子線と試料との正確な位置合わせが前提とされ、集積回路の設計データに基づいて電子線（集束ビーム）をコンピュータ制御することによって、高速、高精度の微細加工処理を実現できる。

【０００４】

【発明が解決しようとする課題】しかしながら、上述した技術には、次のような問題のあることが本発明者らによってあきらかとされた。即ち、集積回路パターンが描画されるウェハには、多くの工程を繰り返す間に歪みや表面段差が生じるので、この段差に応じて、電子線によって描画される図形（露光図形）に補正を施すことが、その後相互に重ね合わされる露光図形の合わせ精度や寸法精度を維持する上で必要である。このためウェハ上に形成される単位露光領域（図３参照）毎に、電子線描画装置のコンピュータ制御によって、個々の設計データに上記段差に応じた所定の補正を施して微細加工を行わなければならない。しかるに、多くの工程が行われ、パターンが半導体ウェハ上の下地パターンに重ね合わされると、工程を繰り返す間にウェハ表面に歪みや段差が生じたり、或は、作業中にウェハ表面に異物が付着したり、或は加工工程途中でウェハ上にマーク上の欠陥が生じるなどして、ウェハに形成された上記基準マークを正確に検出することができなくなる場合がある。このためマーク位置検出値に基づいてウェハと回路パターンの位置合わせの修正を行っても、マークの検出誤差に起因する合わせ誤差が生じ、高い描画精度が得られないと云う不具合が生じる。

【０００５】また、電子線を用いて微細パターンを描画するに際しては、照射時間が長くなる程電子線自体の照射位置の変動量が徐々に大きくなることが知られている。これを抑えるために、一定時間間隔で照射位置が所望の位置となっているか、ステージ上のマークやウェハ上のマーク位置に基づいて較正する必要がある。電子線を用いた描画装置では、描画処理の高速性を保持するために、基準となる合わせマークの位置検出、高さ検出の時間間隔を極力短くして位置マークの較正を短期間に行うことが望まれる。又、較正処理は、ウェハ上にパターンを全面描画する間に、複数回行う必要があり、これら

の処理は如何なるタイミングで行うかが描画の精度を決定することとなる。

【0006】また、ウェハを搭載したステージを一方向に連続移動しながら、ウェハ上にパターンを描画する処理を実行したところ、前記ステージの連続移動の方向とウェハ上に既形成した下地パターンの座標軸の方向とで、回転段差が生じることが明らかとなった。この回転誤差により最大５００μm程度座標のずれが生じる点が存在することもある。従来はこの回転誤差を補正するために、誤差検出後、ウェハが搭載されたステージを回転誤差分だけ微小回転する手法が採られていた。しかしながら、ウェハの保持手段として静電チャック方式が採用されるに至ると回転修正が困難となる。これは静電チャック方式では、ウェハを静電気によりステージ上に固定しているが、この静電チャック方式の保持力は、室内から描画装置の真空状態に移動する際に一旦解除され描画装置内での回転位置を最良とするために、位置決めを行うことはできない。

【0007】また、電子線を用いて回路パターンを描画する際、試料（ウェハ）に電子線が照射されたときに試料が帯電し、このときの電荷により次に回路パターンを描画する際に電子線の照射位置が、所望の位置よりシフトする。この照射位置のシフト量は、電子線の電流値に依存するもので、電流値が大きくなる描画処理時に大きくなり、回路パターンを高精度に描画する際に支障が生じる。また、１の電子線処理により描画可能な偏向領域の境界部（隣接偏向領域との境界部）は、電子線の偏向歪が大きくなり、この境界部近辺では高い精度の描画が行えない。さらに、電子線自体がクーロンの法則に従って自己の電荷間で互いに影響を与え合い、描画工程時に輪郭が不明瞭となったり、電子線自体に揺らぎが生じて描画される回路パターンの寸法や位置にばらつきが生じる。これらの問題点は、特に高精度が期待される極微細の回路パターン描画工程で顕著になる。

【0008】本発明は、上記事情に鑑みて成されたもので、第１の目的は前記ウェハ上の欠陥、異物並びにウェハの歪の影響を少なくして精度の高い描画を可能とした電子線描画方法を提供することである。又、第２の目的は、ステージが連続移動される描画装置において電子線によるパターンの描画処理と位置の較正処理とを効率良く行うべく、マーク検出動作と電子線の照射動作とを効率よく行う電子線描画方法を提供することである。又、第３の目的は静電チャック方式が採用された描画装置においても、ウェハの回転誤差を精度良く補正することを可能にした電子線描画方法を提供することである。又、第４の目的は照射された電子線が帯電したウェハにより、又は自己の電荷により、その照射位置がずれた場合であっても、精度の良く描画することが可能な電子線描画装置及び描画方法を提供することである。この発明の前記ならびにそのほかの目的と新規な特徴については、

本明細書の記述および添附図面から明らかになるであろう。

【0009】

【課題を解決するための手段】本願において開示される発明のうち代表的なものの概要を説明すれば、下記のとおりである。すなわち、本発明の描画技術は、例えば、電子線描画技術に適用した場合は、ウェハ上の複数の合わせマーク位置と高さの検出に際し、前記試料上歪、欠陥、異物などによって、前記試料面上のマーク位置と高さの検出精度劣化を防ぐため、前記試料の複数の検出データを試料の品種、製造工程、面内分布などの統計処理によって、分布から外れた検出データを除外して残りのデータを用いて電子線（荷電ビーム）の偏向と電子線の形成および電子線のビーム焦点位置を合わせ、試料上へパターンを描画するようにしたものである。また、ウェハを搭載したステージを連続して移動しながら、ウェハ上にパターンを描画する際に、電子線（荷電ビーム）の偏向量によって、ウェハ上の描画領域を前記ステージの連続移動方向と直交方向に分割し、それぞれの領域毎に前記マーク位置と高さの検出とパターン描画の繰返して較正処理を行うようにしたものである。又、ウェハを搭載したステージを連続して移動しながら、ウェハ上にパターンを描画する際に、前記ステージの連続移動の方向とウェハ上に形成した下地パターンの座標軸の方向との回転誤差を計測し、前記回転誤差が小さい場合は電子線の偏向系に補正を加えることによって、また、前記回転誤差が小さい場合は、電子線の偏向系に補正を加えることと電子線の形状の回転に補正を加えることによって、前記回転誤差を補正して描画するようにしたものである。又、ウェハの移動と電子線の偏向走査と電子線のオンオフとを組合せ、ウェハ上へパターンを描画する方法において、ウェハ上に描画するパターンの寸法、位置座標などを複数の基準点を中心とした座標に変換し、各々の座標に基づいて、１つの描画点に対し複数重ね露光するものである。

【0010】

【作用】上記した本発明の電子線描画技術によれば、ウェハ上の複数の合わせマーク位置と高さの検出に際して、前記の検出データが前記試料の位置と高さを反映したものか、前記試料面上の欠陥、異物並びに試料の歪を含んだものかを前記検出データの統計処理により排除することができる。例えば、ウェハ上に特定の配線膜や絶縁膜の堆積、エッチング加工の後のウェハの歪を基に、マーク位置や高さの分布を求め、これより外れた検出データを除く等の処理が可能となる。また、ウェハを搭載したステージを連続して移動しながら、ウェハ上にパターンを描画する際に、電子線のドリフト量によって、ウェハ上の描画領域を前記ステージの連続移動方向と直交方向に分割することで、描画時間を大幅に増加することなく、それぞれの領域毎に前記マーク位置と高さの検出

とパターン描画して精度の向上を図ることができる。また、ウェハを搭載したステージを連続して移動しながら、ウェハ上にパターンを描画する際に、前記ステージの連続移動の方向とウェハ上に形成した下地パターンの座標軸の方向との回転誤差を計測し、前記回転誤差が小さい場合は電子線の偏向系に補正を加えることによって、また、前記回転誤差が大きい場合は、電子線の偏向系に補正を加えることと電子線の光電子面の形状に回転に補正を加えることによって、前記回転誤差を補正して描画するようにしたものである。また、ウェハの移動と電子線の偏向走査と電子線のオンオフとを組合せ、ウェハ上へパターンを描画する方法において、ウェハ上に描画するパターンの寸法、位置座標などを規定した一種類のパターンデータに対して、複数の基準点を中心とした複数の座標を得、これを基準に、複数回重ね露光するものである。これにより、電子線の揺らぎが低減され、電子線偏向境界部での接続精度の向上が実現できる。

【0011】

【実施例】以下、本発明の一実施例を添付図面に基づいて説明する。図1は本発明に係る電子線露光装置の構成を示すブロック図、図2は電子ビーム装置の構成を示す斜視図、図3はウェハ上の単位露光領域の配列状態とアライメントマークとの関係の一例を示す説明図、図4はマーク検出データの統計処理フロー、図5、図6はウェハの面内分布によるデータ処理の説明図、図7～図10は被露光物（ウェハ）の露光面の高さに応じた偏向係数を求める処理の一例を示した説明図、図11は偏向係数を求める際の基準マーク検出位置の一例を示す説明図、図12は本実施例の電子線露光装置による描画方式の説明図、図13はウェハ回路パターンの座標軸とステージの移動方向の間に生じる回転誤差を示す説明図、図14は第2実施例の電子線照射手法を用いるデータの生成手順を示す説明図、図15は上記データに基づく電子線照射の手順を示す説明図である。

【0012】（第1実施例）先ず図1、図2を参照して、電子線描画装置による描画手順について説明する。図中1で示す試料台は、水平面内においてX方向及びY方向（例えば図3の横方向と縦方向）に移動自在なX－Yステージからなり、該試料台1の上には、被露光物（試料）として例えば、表面に感電子線レジストが被着された半導体ウェハ2が載置される。試料台1の上方には電子線源3が設けられており、試料台1に載置されたウェハ2に向けて電子線4が照射される。電子線源3と試料台1との間には、成形器5、回転レンズ6、偏向器7及び対物レンズ8などからなる電子光学系の電子線調整装置が設けられている。

【0013】前記電子線源3から照射される電子線4は成形器5を通過することによってその内部に設けられたアパーチャ5a，5b（図2）により光電子面が所定の形状（方形）に変換された後、回転レンズ6による回転補正と偏向器7による偏向補正がなされ、これによりウェハ（被露光物）2上の任意の位置に任意の光量にて電子線が照射される。そして前記対物レンズ8によって、照射された電子線4の被露光物2の表面に対する焦点合わせが行われる。

【0014】前記試料台1の被露光物2の上方位置には、ウェハ2に当てられた電子線4の反射光を検出してウェハ2における電子線4の入射部位の高さを測定するZ測定器23が形成されている。又、試料台1上方位置には、前記電子線4又は他の光源21を試料上面のマーク形成部に照射したときの二次電子、又は散乱光22を検出し、この検出結果に基づいて被露光物上のマーク位置を検出するマーク検出器24が設けられている。これらのZ測定器23およびマーク検出器24はいずれも制御計算機16に接続されて、その検出結果が該計算機16に送られるようになっている。

【0015】光電子面を所定形状に変換する前記成形器5は、成形器制御部9および成形信号発生部10を介して高速アクセス可能な第1のバッファメモリ25更には制御計算機16に接続され、回転レンズ6は回転レンズ制御部12を介して、演算部11、第1のバッファメモリ25、制御計算機16に接続される。又、回転レンズ制御部12は第2のバッファメモリ25、更に制御計算機16に接続されている。又、偏向器7は、偏向制御部14および偏向信号発生部15を介して前記演算部11と第2のバッファメモリ25とに夫々接続されている。一方、対物レンズ8は対物レンズ制御部17及び第2のバッファメモリ25を介して演算部11及び制御計算機16に接続されている。又、試料台1のX－Yステージの動作を制御する試料台制御部19は制御計算機16に接続されている。

【0016】上記制御計算機16には、被露光物2に露光する図形に関する大量の情報が格納される、例えば大記憶容量のハードディスク装置などからなる、描画データ格納部20が接続されている。この描画データ格納部20は制御計算機16によって適宜選択された所定の図形情報を、必要に応じて、高速アクセスが可能な第1のバッファメモリ18に転送するように構成されている。また、前記制御計算機16には、被露光物（ウェハ）2のマーク位置や高さに関するデータを、ウェハの品種（CMOSLSI，バイポーラLSI，…）、当該露光が行われる製造工程の別、ウェハの面内分布に応じて格納するデータベース26が接続されている。そしてこのデータは、個々のウェハ2に対応した露光ジョブプログラムにリンクして逐次取り出せるようになっている。

【0017】一方、演算部11は、バッファメモリ18に保持されている図形情報に基づいて、電子線4の光電子面の形状（方形の大きさ等）や偏向量（電磁偏光、静電偏光の制御量）などを演算して、この各種演算結果に応じた種々の制御信号を出力する。この演算部11から

の制御信号を受けた成形信号発生部１０および成形器制御部９は、該信号に基づいて成形器５の制御（光電子面の形状の制御）を行う。更に上記制御信号は回転レンズ制御部１２、偏向信号発生部１５、対物レンズ制御部１７にも送られる。このうち前記回転レンズ制御部１２は回転レンズ６の作動制御を行い、偏向信号発生部１５は偏向制御部１４と協働して偏向器７の制御を行う。そして対物レンズ制御部１７は対物レンズ８の制御（焦点合わせ）を行なうようになっている。この場合、制御計算機１６と偏向信号発生部１５、計算機１６と回転レンズ制御部１２、および、計算機１６と対物レンズ制御部１７の間には第２のバッファメモリ２５（記憶手段）が介設されており、この第２のバッファメモリ２５は前記Ｚ測定器２３からの高さデータが入力されるようになっている。

【００１８】そして上記Ｚ測定器２３により得られる検出結果（高さデータ）は後述の素子領域P_1，P_2…P_n（図３参照）の各々の偏向領域毎（面内分布毎）に、検出により測定された露光面高さが認識され、この認識された高さに応じて第２のバッファメモリ２５に予め格納された任意の補正係数が選択的に読み出される。このように読み出された補正係数は前記偏向信号発生部１５、回転レンズ制御部１２および対物レンズ制御部１７にその旨を表す信号として送られる。

【００１９】図２は上記電子ビーム装置の描画装置の構成を示す斜視図である。図２に示す試料の水平面内において移動自在なＸ－Ｙステージ（試料台）１の上には表面に感電子線レジスト等が塗布されたウェハ（被露光物）１が搭載されている。試料台１の上方には、電子線源たる電子銃３が設けられており、ウェハ２に向けて電子線４が放射されるように構成される。電子線源３から試料台１に至る電子線４の経路には、成型器５、回転レンズ６、偏向器７、対物レンズ８などからなる電子光学系が設けられて電子線調整部（装置）が構成される。

【００２０】かかる構成の電子線描画装置を用いたウェハ位置合わせ／パターンの露光の動作手順を図３を参照して具体的に説明する。半導体ウェハ２の露光面は、図３に示すように複数の素子領域（単位露光領域）P_1，P_2…P_nに区切られており、各々の素子領域P_1，P_2…P_nの所定位置には、アライメントマークK_1，K_2…K_nが設けられている。このアライメントマークは、例えばウェハ表面に集積回路の素子を形成する際に複数回繰り返される露光工程にて、各々の工程毎に用いられる複数の回路パターン相互の重ね合わせ精度を維持するためのもの（位置合わせ用）である。実際にこのアライメントマークを用いて位置合わせを行うには、該アライメントマーク（K_1，K_2…K_n）に電子線４又は光源２１からの光２２を当てて、このときの散乱光をＺ検出器２３又はマーク検出器２４によって検出して、アライメントマーク位置を３次元的に認識する。そして、このように検出したデータをL_i（x_i，y_i，z_i）と表して、該データL_iがウェハ２上に形成されたアライメントK_iの情報（マーク形成路のデータ；理想格子点）を正しく反映したものかどうかを、例えば図４に示したフローチャートで判別する。このようにフローチャートに従ってデータ内容を比較することにより、被露光物（ウェハ）２上に異物が付着したり、下地段差が生じていた場合に生じる、アライメントマークの検出エラーが排除される。

【００２１】このフローチャートでは、先ずステップ１でウェハ上に設けられた複数のアライメントマーク（K_1，K_2…K_n）を測定し、ステップ２でこの測定データを座標変換してデータL_i（x_i，y_i，z_i）を得る。そして、該得られてたデータL_iとマークを表す理想格子点（設計段階での値）との誤差ΔL_iを算出し、ステップ３～６にて該誤差ΔL_iが、①過去の検出データに基づく品種毎の統計処理によって既に決定されている基準値以下となっているか否か、②製造工程毎に決定される基準値以下となっているか否か、③ロット毎に決定されている基準値以下となっているか否か、④ウェハの面内分布毎に決定された範囲内か否かが夫々判別される。ここで品種毎とは、ウェハに形成されるＬＳＩの種類（例えばバイポーラＬＳＩ，ＣＭＯＳ…）の違いを云い、工程毎とはアルミ１層、層間絶縁膜、アルミ２層…などの製造工程の違いを云う。そして、これらの判別が全て“Ｙｅｓ”のときにはステップ７で、このデータL_iを採用して新たなマーク位置，高さを表すデータを算出する。一方、ステップ３～６の何れかが“Ｎｏ”のときには、更にステップ８でK_1～K_nのエラー測定比率が所定値（５％）以上であるか否かが判別される。ここでエラー測定比率とは、データを検出した全てのマーク（図３に示す各マーク）のうち、その検出値が上記基準値より外れたマークが幾つあったかを表す比率である。この判別結果が“Ｎｏ”のときにはステップ１に戻って、データの検出からやり直し、一方、“Ｙｅｓ”のときには、上記基準値から外れたデータを既に記憶されている値と置き換えて（ステップ９）、その後の処理が行われる。尚上記ステップＳ３～Ｓ６の判別の基準となるものは、それまでに行われた処理で検出したデータであり、このデータを被露光物の品種、製造工程、ロット、面内分布により分類して記憶しておき、この分類条件に対応したウェハの検出データが、新たなデータの検出時に適宜読み出されて比較の基準とされる。この方式では、被露光物の検査が繰り返されると、それだけデータが多く蓄積されるので、判定基準の精度を経時的に向上させることができる。

【００２２】次に、被露光物（ウェハ）の面内分布に基づいて、上記検出データL_iに関する異常データの排除、および補足を行う手順について図５、図６を用いて説明する。図５に示すように、検出データL_iに異常点のデータ（L_{i+4}）が含まれている場合、各検出データ

の理想格子点からの誤差分ΔLに対し、異常点データを差分し（L_{i+4}）、これを平均値処理して、この処理したデータを異常点データと置換する。

【0023】ところで素子領域（単位露光領域）P_1，P_2…P_nに対する描画データ格納部20内の図形情報に基づいて被露光物（ウェハ）2に露光処理を行うに当たっては①該被露光物（ウェハ）2の露光面高さに応じた対物レンズ8の制御による焦点合わせおよび偏向器7の偏向係数に対する補正（第1の補正）、②被露光物2上の素子領域P_1，P_2…P_nを形成している座標系と電子光学系の座標系の不一致および被露光物2の有する歪みに対する偏向器7の偏向係数に対する補正（第2の補正）が必要である。そこで本実施例では上述したデータ処理を終了後、以下の修正処理を行う。

【0024】即ち上記露光面高さに応じた偏向器7の偏向係数の算出及びこれに対する補正を以下の手順に従って行う。被露光物2に対する露光操作に先だっては高さの補正が行われる。この場合、先ず高さの差が既知の異なる高面32および低面31を有する試料を試料台1の上に設け試料の高面32，低面31の標準マークM_H，M_Lの位置を検出する。この場合M_Hを検出するに当たっては、図7、図8に示すように試料台1の位置を移動させ、電子線4を偏向させてM_Hを照射する際の二次電子を、マーク検出器24（図1）にて検出し、これにより、異なった偏向位置での標準マークM_H検出結果を得る。一方、標準マークM_Lを検出するに当たっても、図9、図10に示すように、上記と同様に、異なった偏向位置（試料台1を移動させて）で標準マークM_Lを検出する。そして、試料台1を所定の距離だけ移動させながら偏向領域内の複数の位置m_1，m_2，m_3，…m_n（図11）において標準マークM_H，M_Lの位置を夫々検出することにより、露光面高さの変化に応じた歪み量が求められる（尚、この場合、当該位置m_1，m_2，m_3，…m_nを表すデータは試料台1（X－Yステージ）の送り量に基づいて試料台制御部19により正確に求められると仮定する）。

【0025】図1の偏向信号発生部15に与えられるべき偏向補正係数は、X，Yを偏向のX，Y座標、ΔX，ΔYを試料台1の位置より求めた歪み量とした場合に、表される次式(1)，(2)の左辺を0とする係数A_0，A_1…A_9，B_0，B_1…B_9である。

$$\Delta X = A_0 + A_1 X + A_2 Y + A_3 X^2 + A_4 XY + A_5 Y^2 + A_6 X^3 + A_7 X^2 Y + A_8 XY^2 + A_9 Y^3 \quad \cdots (1)$$

$$\Delta Y = B_0 + B_1 X + B_2 Y + B_3 X^2 + B_4 XY + B_5 Y^2 + B_6 X^3 + B_7 X^2 Y + B_8 XY^2 + B_9 Y^3 \quad \cdots (2)$$

【0026】又、任意の試料面高さZでの偏向補正係数$A_n{}^Z$，$B_n{}^Z$は、図7～図10に示した標準マークのうち、標準マークM_Hのデータを上記(1)，(2)式に当てはめて求めた偏向補正計数を$A_n{}^H$，$B_n{}^H$とし、標準マークM_Lを用いて求めた偏向補正係数を$A_n{}^L$，$B_n{}^L$とすると、

$$A_n{}^Z = (A_n{}^H - A_n{}^L)\ Z/H \quad \cdots (3)$$

$$B_n{}^Z = (B_n{}^H - B_n{}^L)\ Z/H \quad \cdots (4)$$

として与えられる（ここでHは、標準マークM_H，M_Lの高さの差である）。

【0027】一方、対物レンズ8に関しては焦点位置および非点収差に対する補正が行われる。この場合の焦点補正の電流値I_fは偏向座標X，Yに応じて定まるもので次式(5)にて求められる。

$$I_f = \alpha_0 + \alpha_1 X + \alpha_2 Y + \alpha_3 X^2 + \alpha_4 XY + \alpha_5 Y^2 + \alpha_6 X^3 + \alpha_7 X^2 Y + \alpha_8 XY^2 + \alpha_9 Y^3 \quad \cdots (5)$$

ここでα_0は試料面高さZに応じて変化するもので次式(6)で求められる。

$$\alpha_0{}^Z = \alpha_0{}^L + (\alpha_0{}^H - \alpha_0{}^L)/H \cdot Z \quad \cdots (6)$$

【0028】又、非点収差補正の電流値I_{SX}は、同様に、

$$I_{SX} = \beta_0 + \beta_1 X + \beta_2 Y + \beta_3 X^2 + \beta_4 XY + \beta_5 Y^2 + \beta_6 X^3 + \beta_7 X^2 Y + \beta_8 XY^2 + \beta_9 Y^3$$

$$I_{SY} = \gamma_0 + \gamma_1 X + \gamma_2 Y + \gamma_3 X^2 + \gamma_4 XY + \gamma_5 Y^2 + \gamma_6 X^3 + \gamma_7 X^2 Y + \gamma_8 XY^2 + \gamma_9 Y^3 \quad \cdots (7)$$

として与えられる。ここでβ_0，γ_0がZの関数として

$$\beta_0{}^Z = \beta_0{}^L + (\beta_0{}^H - \beta_0{}^L)\ Z/ \quad \cdots (8)$$

$$\gamma_0{}^Z = \gamma_0{}^L + (\gamma_0{}^H - \gamma_0{}^L)\ Z/H \quad \cdots (9)$$

として与えられる。

【0029】本実施例の電子線露光装置では試料面の高さに応じて変化する補正係数$A_n{}^Z$（$A_1{}^Z$，$A_2{}^Z$‥‥$A_9{}^Z$），$B_n{}^Z$（$B_1{}^Z$，$B_2{}^Z$‥‥$B_9{}^Z$），及び$\alpha_0{}^Z$，$\beta_0{}^Z$，$\gamma_0{}^Z$に関しては、①前記高、低2面間の高低差Hあるいはその外側をも含んだ試料面高さを按分し、②各試料面高さZ_1，Z_2，Z_3，…Z_nに対応した値を、前もって算出されたγ_1，γ_2‥‥γ_3，β_1，β_2‥‥β_3（一定値）と共に前記第2のバッファメモリ25に格納し、③さらに各アライメントブロックK_1，K_2‥‥K_n（図3参照）毎に算出した各露光領域毎の位置合わせのための補正係数C_{01}，C_{11}，C_{21}，C_{31}，D_{01}，D_{11}，D_{21}，D_{31}を前記第2のバッファメモリ25に格納し、④これを基に例えば個々の素子領域P_1，P_2…P_nに対応する各露光領域毎に露光面高さZに依存する補正係数を、測定された露光面高さZに応じて第2のバッファメモリ25内に予め格納されている値より選択し、⑤既定の値をとるものとともに当該第2のバッファメモリ25から読み出して制御計算機16を介在させることなく直接的に偏向信号発生部15、回転レンズ制御部12および対物レンズ制御部17へ与える。この手順によって、個々の単位露光領域の露光作業が行なわれる。

【0030】電子線露光装置の制御計算機16に、被露

光物（ウェハ）に関するデータ、即ち、ウェハの種類、製造工程、着工ロット、面内分布等の情報を有するデータベース２６を接続し、これらのデータを被露光物の露光制御用のジョブデータにリンクして取り出せるようにし、更に被露光物の実際のマーク検出データを前述の図４に示すフローに従って、これら取り出されたデータを基に判別することで、被露光物への露光の重ね合わせ精度を確実に向上させることができる。

【００３１】図１２は、上記電子線露光装置による描画方式の一例を示す説明図である。この描画方式では、電子線描画装置（図２）のX－Yステージ（試料台）１はY方向（図１２中上下方向）にのみ連続移動されるようになっている。これは上記描画装置では、過電流を防止するためにX－Yステージが金属以外の材質（セラミック製）にて構成され、この場合、ステージの重量が大きくなって、このステージをX－Y両方向に連続移動させる構成とするには装置全体の機能向上（拡大化）を図らなければならないからである。

【００３２】一方向（Y方向）のみ連続移動させる描画方式を行うに当たっては、ウェハ２の露光面がステージの連続移動方向（図中上下方向）と直交方向に縦分割されて複数の描画領域が形成され、それぞれの描画領域への描画動作を一動作単位として制御（露光）が行われる。尚、ビーム装置が一回の動作で連続描画可能な動作時間は、一定となっており、従って、一動作単位として設定された上記描画領域は、上記動作時間内に十分描画可能な範囲より小さな領域に設定される。そして、一動作単位終了毎に、ウェハ上のマーク（アライメントマーク）の位置検出とマーク高さ検出が行われる。そして、その後、次の描画動作が行われ、これら一連の処理が繰り返される。この場合、マーク検出と描画動作との間は、X－Yステージ１が、その連続移動方向と直交方向に、ステップ移動され、マーク検出と当該領域でのパターン描画動作とが交互に繰返し行われる。尚、この実施例ではM_1点からE_1点までの動作（描画／較正）を一動作単位とし、描画領域（図１２中斜線で示す領域）は電子線のドリフト量の２倍の幅（図４の格子２個分）にて、その横幅（ステージ移動方向と直交する方向の幅）が決定されている。

【００３３】上記位置合わせマーク（アライメント）の検出は、試料のマーク部（ウェハのディスクライブ領域に形成される）に電子線を照射し、図１に示すマーク検出器２４にて、反射電子（又は二次電子）を検出することにより行う（先ず、図中１点鎖線で示す経路M１に沿ってマーク検出が行われる）。マーク検出器４にて検出されたマーク位置データは、図１に示すデータベース（マーク位置データ格納部）２６に保管される。その際に、描画する電子線と試料（ウェハ）２との相対位置がドリフトすると描画パターンの位置精度が劣化するため、この描画方式では一定時間経過毎に、電子線４と試料（ウェハ）２との相対位置のドリフトに対する補正（較正処理）が行われる。

【００３４】位置合わせマーク（アライメントマーク）K_1，K_2…は、図３に示したように、ウェハ２のディスクライブ領域の周辺部に形成されるので、位置合わせマークの検出と描画マークの検出とは同時にできない。そこで、分割された領域毎にその領域のマーク検出を行ない、その後に当該領域内の回路パターンの描画を行うようにしている（図中２点鎖線で示す経路E１に沿って行われる）。この描画方式ではマーク位置検出処理と描画処理とをウェハの分割された描画領域毎に処理を行っており、これによってマーク位置検出処理と描画処理との切換えに要するステージ移動時間を少なくすることができる。この結果効率よく電子線４と試料（ウェハ）２とのズレの補正が行われ、ウェハ上への回路パターンの描画精度が一層向上する。

【００３５】図１３は、ステージの連続移動方向とウェハ上のパターンの機械的な回転誤差を模式的に示したものである。半導体製造ラインでは、ウェハ上のパターンの機械的な回転誤差を管理しないと、場所によっては最大５００μm／１００mm程度座標がずれる。従って本実施例の描画方式では、これらの誤差をステージのX－Y移動方向の座標軸（例えばX軸）とウェハ２上に形成した下地パターンの座標軸（X軸）との回転角度差θ（図１３）を計測し、この計測値θに基づいて任意の描画点F（x，y）に回転誤差の補正を行って修正後の座標P（x，y）を得る。尚、検出値θを計測するに当たっては、少なくともウェハ表面に形成された２箇所の合わせマークを検出して、これらを互いに比較することにより、測定される。

【００３６】この回転誤差θは描画パターンの位置精度を劣化させるものである。これは、電子線による描画では、図２に示したアパーチャにより形成される方形の光電子面が、連続的に並べられて所望のパターンが形成されるため、回転誤差θが大きくなるにつれ、方形の光電子面同士の接合点に大きな段差が生じ、仮に、直線を描画しようとした場合には、各光電子面が階段状に並んで段差が生じるからである。本実施例では値θが小さい場合は、電子線４の偏向系に補正を加えることによってのみ、該回転誤差を補正し（図１の偏向器７に上記回転誤差の補正分を加える）、θが大きい場合は、前記偏向器７による補正を行うと共に電子線の回転レンズ６に補正を加えて光電子面の形状（方形）自体にも該回転誤差の補正をする。このように光電子面自体に回転誤差に応じた補正を行うことにより、方形の光電子面が回転誤差の生じた座標系に対し、角度補正がなされ、当該光電子面を連続的に並べた図形（パターン）に段差が生じなくなる。このように回転誤差に応じた補正を行うことによってステージの連続移動方向（図中X，Y方向）とウェハ上のパターン（ウェハ上の座標、図中x，y方向）との

機械的な回転誤差θに拘らず、常にパターンの描画精度を高く保持することができる。

【0037】（第2実施例）図14は、図2の電子ビーム装置を用いて描画を行うに当り、描画装置の試料台（X－Yステージ）1がX－Y方向にステップ移動させる描画方式（第2実施例の描画方式）での描画データ（露光の座標系）の変換の手法を示す説明図である。この描画方式では、ウェハ上に描画する描画領域（露光の座標点）を指定するために先ず描画装置側のフィールド（単位露光領域）内の座標（Fx，Fy）及びこれを中心に4つの基準座標（Fx+Δ，Fy+Δ），（Fx-Δ，Fy+Δ），（Fx-Δ，Fy-Δ），（Fx+Δ，Fy-Δ）を設定する。今仮に、座標（Fx，Fy）を基準とした所定のパターン座標（Px，Py）を描画する場合を考える。この場合、先ず、4つの基準座標（Fx+Δ，Fy+Δ），（Fx-Δ，Fy+Δ），（Fx-Δ，Fy-Δ），（Fx+Δ，Fy-Δ）を中心とした、上記パターン座標（Px，Py）の4つの変更座標を求める。この場合、4つの座標は、（Px-Δ，Py-Δ），（Px+Δ，Py-Δ），（P+xΔ，Py+Δ），（Px-Δ，Py+Δ）となる。そして、この4種類の各々のパターンデータ（座標）に基いて4回の描画処理の重ね合わせが行われる。尚、実際に描画を行うに当たっては、多数のパターン座標に対し4つの変換されたパターン座標が夫々算出されることとなる。図14のデータ（a）～（d）は、①座標（Fx，Fy）をX方向，Y方向に所定移動量＋Δだけシフトさせた場合（Fx+Δ，Fy+Δ）、②X方向に－Δ，Y方向に＋Δシフトさせた場合（Fx-Δ，Fy+Δ）、③X方向に＋Δ，Y方向に－Δシフトさせた場合（Fx-Δ，Fy-Δ）、④X方向，Y方向に共に－Δシフトさせた場合（Fx+Δ，Fy-Δ）の、元のパターンデータ（Px，Py）に対するシフト後のパターンデータ（座標）の変換後の値を示す。この例では、フィールドの中心座標（Fx，Fy）のシフト方向が移動した分、パターンデータの座標（Px，Py）を反対方向にシフトさせて、フィールド座標が±Δシフトした分だけずれる描画データを、反対方向に修正している。上記のシフト量Δは、X方向，Y方向共に電子線描画装置の最大電磁偏向幅と最大静電偏向幅の合計（描画可能範囲）の1／2以下としているが、これは当該描画範囲の中で少なくとも4回の描画処理の重ね合わせを行うため、1回の移動後の描画点が必ず描画範囲内に存在するようにしている。

【0038】図15は、上記の描画方式を模式的に示したもので、1つのフィールド（単位露光領域）にシフト量がX，Y方向に±Δシフトされた4つの基準座標（Fx，Fy），（Fax，Fay），（Fbx，Fby），（Fcx，Fcy），（Fdx，Fdy）が設けられ、各々の座標を基準として、1の描画点（Px，Py）が異なった座標として表されている。そして、上記4つの基準座標を夫々中心とした4回の描画処理が重ねて行われることとなる。

【0039】この描画方式では、電子線の偏向と電子線のオン／オフとを組合せて偏向制御が行われている。電子線4の偏向は、電磁偏向と静電偏向とが組み合わされて行われている（電磁偏向は最大ビーム偏向幅5mm程度，静電偏向は電子線偏向幅50～500μm程度）。従って、X－Yステージが固定された状態での当該描画装置の描画可能な範囲はこれら2つの偏向幅の和となる。従って、上述のように、1つのパターンデータに対して、4回の重ね露光するに当たって、前記X－Yステージの移動量（シフト量Δ）を、電子線4の電磁偏向幅と静電偏向幅と和の1／2シフトさせると、4回重ねの露光が効率良く行われる。このように1の描画領域に4回の露光工程を施した場合、電子線4の揺らぎ、特に描画領域同士の境界部で電子線4の不明瞭化が平均化され、精度のよい照射が可能となる。

【0040】以上説明したように、本実施例では、ウェハ上の複数の合わせマーク位置と高さの検出に際し、前記試料上歪、欠陥、異物などによって、前記試料面上のマーク位置と高さの検出精度劣化を防ぐため、前記試料の複数の検出データを試料の品種、製造工程、面内分布などの統計処理によって、分布から外れた検出データを除外して残りのデータを用いて電子線（荷電ビーム）の偏向と電子線の形成および電子線のビーム焦点位置を合わせ、試料上へパターンを描画するようにしたので、ウェハ上の複数の合わせマーク位置と高さの検出に際して、前記の検出データが前記試料の位置と高さを反映したものか、前記試料面上の欠陥、異物並びに試料の歪を含んだものかを判断して、これを排除することができる。また、ウェハを搭載したステージを連続して移動しながら、ウェハ上にパターンを描画する際に、電子線（荷電ビーム）の偏向量によって、ウェハ上の描画領域を前記ステージの連続移動方向と直交方向に分割し、それぞれの領域毎に前記マーク位置と高さの検出とパターン描画の繰返して較正処理を行うようにしたので、描画時間を大幅に増加することなく較正処理を行うことができる。又、ウェハを搭載したステージを連続して移動しながら、ウェハ上にパターンを描画する際に、前記ステージの連続移動の方向とウェハ上に形成した下地パターンの座標軸の方向との回転誤差を計測し、前記回転誤差が小さい場合は電子線の偏向系に補正を加えることによって、また、前記回転誤差が小さい場合は、電子線の偏向系に補正を加えることと電子線の形状の回転に補正を加えることによって、前記回転誤差を補正して精度の高い描画が行われる。又、ウェハの移動と電子線の偏向走査と電子線のオンオフとを組合せ、ウェハ上へパターンを描画する方法において、ウェハ上に描画するパターンの寸法、位置座標などを複数の基準点を中心とした座標に変換し、各々の座標に基づいて、1つの描画点に対し

複数重ね露光したので、電子線の揺らぎが低減され、電子線偏向境界部での接続精度の向上が実現できる。

【0041】

【発明の効果】本願において開示される発明のうち代表的なものによって得られる効果を簡単に説明すれば下記のとおりである。即ち、ウェハ表面に欠陥、異物、歪が生じた場合であっても精度の高い描画処理を行うことができる。また、ウェハの描画処理と較正処理とが効率よく行えるので、描画処理全体として処理速度が速くなって、動作効率が高められる。また、X－Yステージの連続移動の方向とウェハ上に形成した下地パターンの座標軸の方向との回転誤差が生じた場合であっても、これを補正して精度の高い描画を行うことができる。１の描画点に対して複数回の重ね露光が行われるので、電子線の揺らぎが低減され、電子線偏向境界部での描画精度が高められる。

【図面の簡単な説明】

【図１】本発明に係る電子線露光装置の構成を示すブロック図である。

【図２】電子ビーム装置の構成を示す斜視図である。

【図３】ウェハ上の単位露光領域の配列状態とアライメントマークとの関係の一例を示す説明図である。

【図４】マーク検出データの統計処理フローチャートである。

【図５】ウェハの面内分布によるデータ処理の説明図である。

【図６】ウェハの面内分布によるデータ処理の説明図である。

【図７】被露光物（ウェハ）の露光面の高さに応じた偏向係数を求める手法の一例を示した説明図である。

【図８】被露光物（ウェハ）の露光面の高さに応じた偏向係数を求める手法の一例を示した説明図である。

【図９】被露光物（ウェハ）の露光面の高さに応じた偏向係数を求める手法の一例を示した説明図である。

【図１０】被露光物（ウェハ）の露光面の高さに応じた偏向係数を求める手法の一例を示した説明図である。

【図１１】偏向係数を求める際の基準マーク検出位置の一例を示す説明図である。

【図１２】本実施例の電子線露光装置による描画方式の説明図である。

【図１３】ウェハ回路パターンの座標軸とステージの移動方向の間に生じる回転誤差を示す説明図である。

【図１４】第２実施例の電子線照射手法を実行する際に用いるデータの生成手順を示す説明図である。

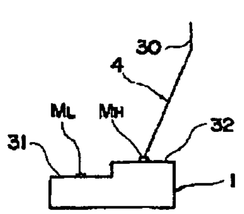
【図１５】図１４に示すデータに基づいた電子線照射の手順を示す説明図である。

【符号の説明】

１　試料台（X－Yステージ）
２　ウェハ
４　電子線
６　回転レンズ
７　偏向器
８　対物レンズ
１２　回転レンズ制御部
１４　偏向制御部
１６　制御計算機
１７　対物レンズ制御部
２０　描画データ格納部
２３　Ｚ測定器
２４　マーク検出器２４
２６　データベース
P_1，P_2…P_n　素子領域
K_1，K_2…K_n　アライメントマーク
M_H，M_L　標準マーク

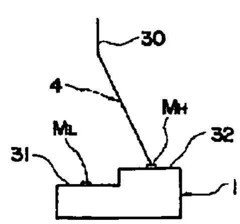
【図７】

【図 ７】



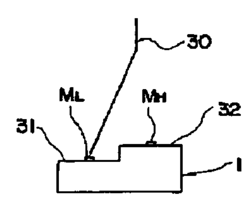
【図８】

【図 ８】

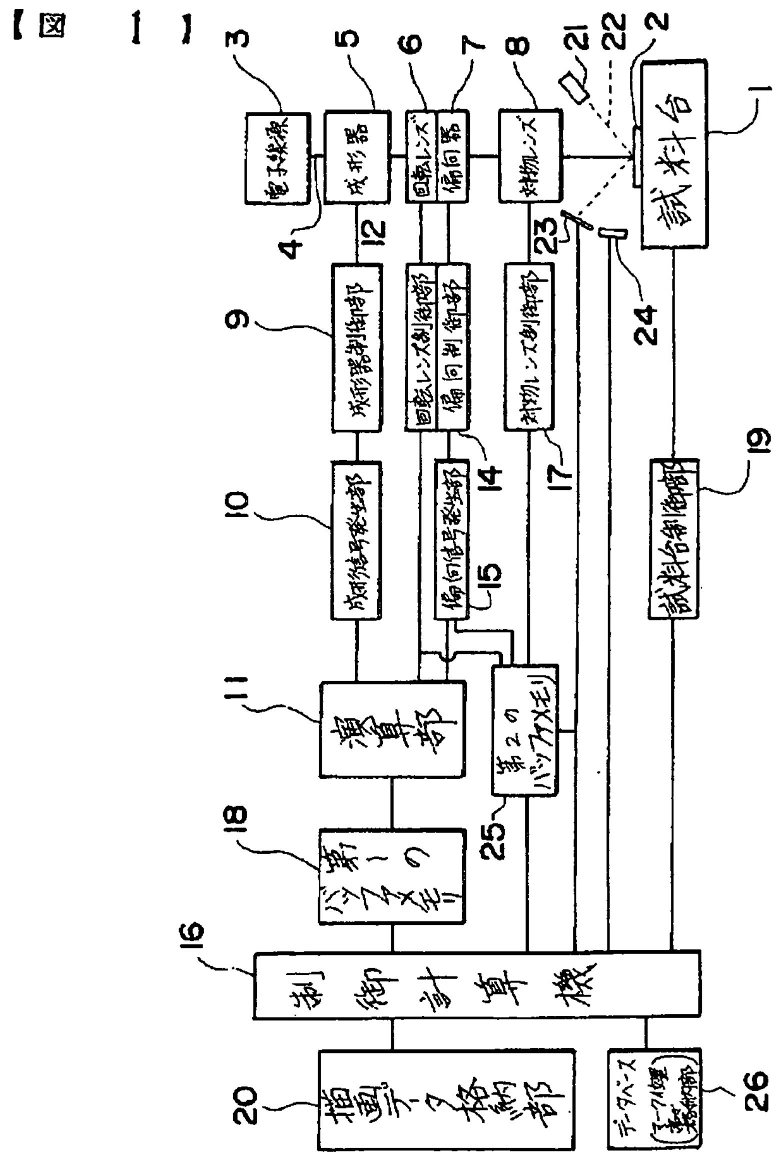


【図９】

【図 ９】

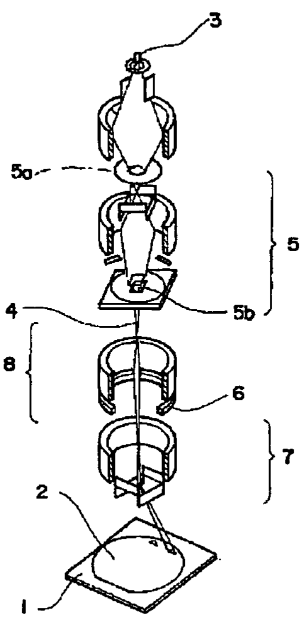


【図１】


【図 1】
試料台
電子線源
成形器
回転レンズ
偏向器
対物レンズ
成形器制御部
回転レンズ制御部
偏向制御部
対物レンズ制御部
成形信号発生部
偏向信号発生部
試料台制御部
演算部
第２のバッファメモリ
第１のバッファメモリ
制御計算機
描画データ格納部
データベース
1
2
3
4
5
6
7
8
9
10
11
12
14
15
16
17
18
19
20
21
22
23
24
25
26

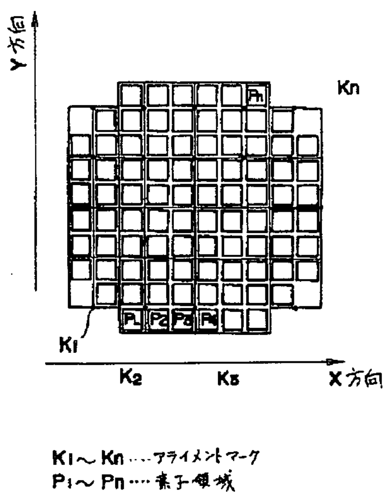
【図2】

【図 2】



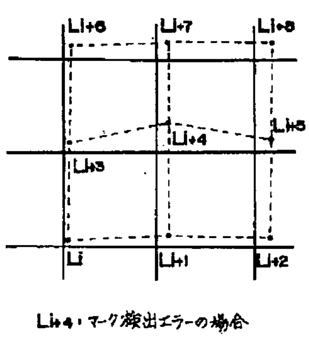
【図3】

【図 3】



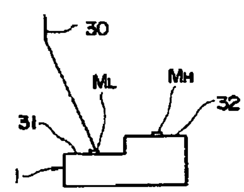
【図5】

【図 5】



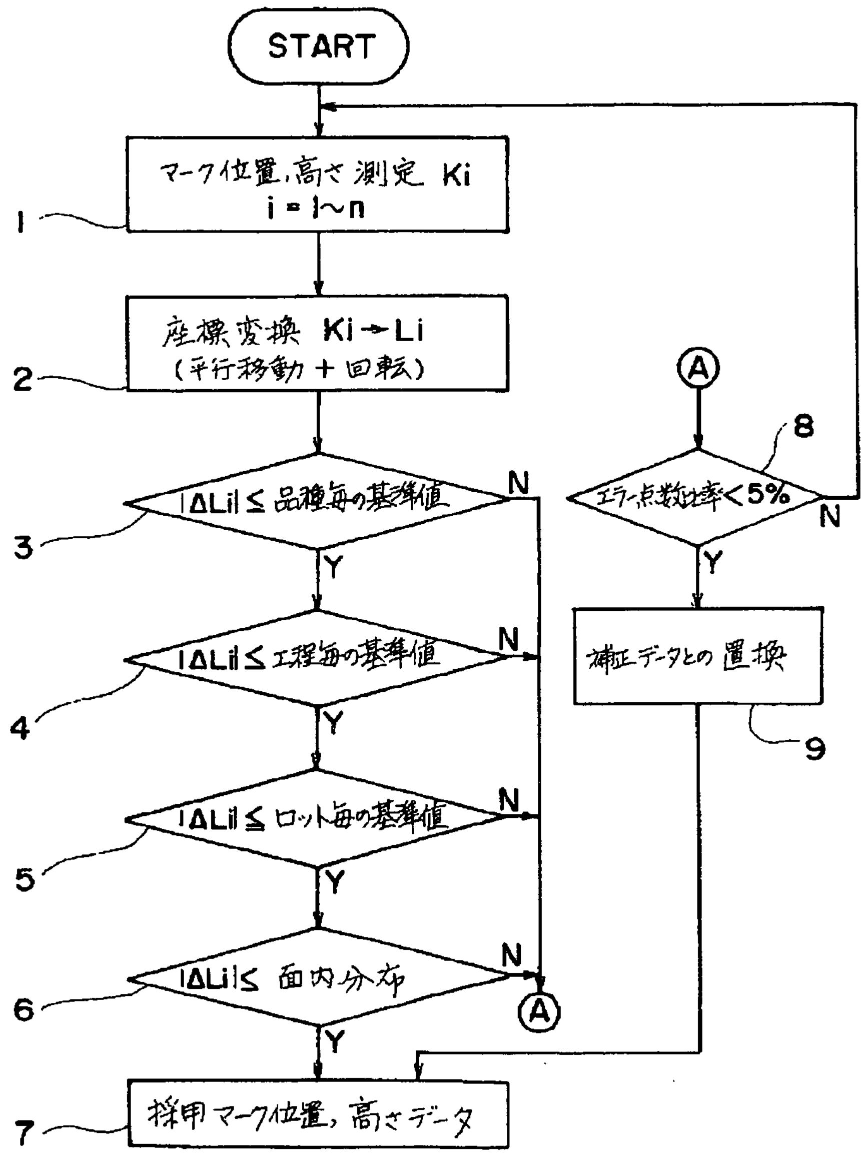
【図10】

【図 10】



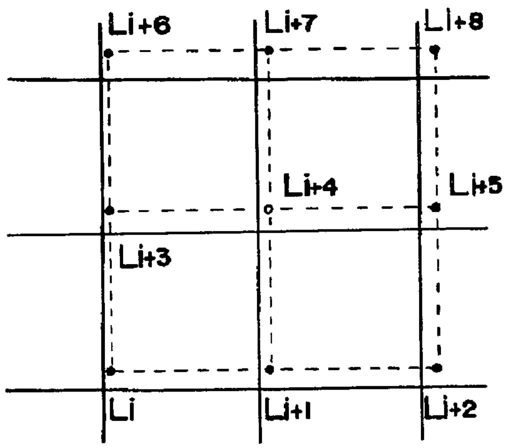
【図4】

【図 4】


START
マーク位置,高さ測定 Ki
i = 1～n
1
座標変換 Ki→Li
(平行移動＋回転)
2
|ΔLi| ≦ 品種毎の基準値
3
|ΔLi| ≦ 工程毎の基準値
4
|ΔLi| ≦ ロット毎の基準値
5
|ΔLi| ≦ 面内分布
6
採用マーク位置,高さデータ
7
Y
N
A
エラー点数比率＜5%
8
補正データとの置換
9

【図6】

【図　6】

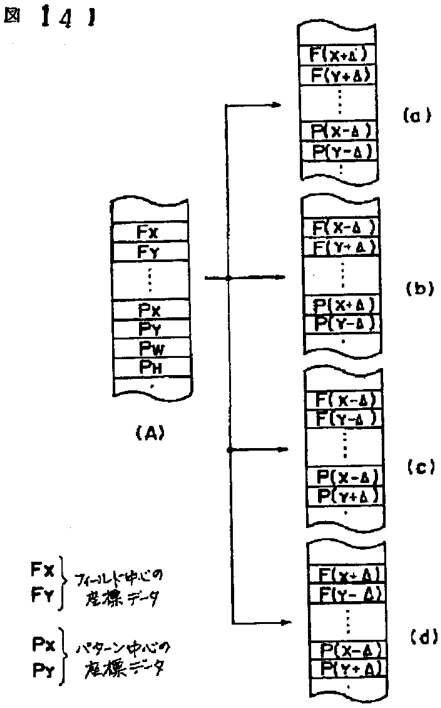


$$L_{i+4}(x\cdot y)=\frac{1}{n-1}\left\{\sum_{i=1}^{n} L_i(x\cdot y)-L_{i+4}(x\cdot y)\right\}$$

Li ＝ 各理想格子点からのシフト量

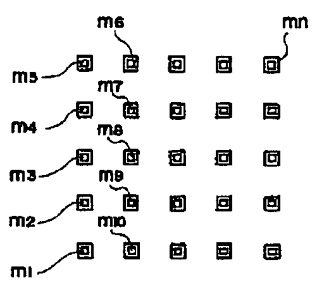
【図14】

【図14】



【図11】

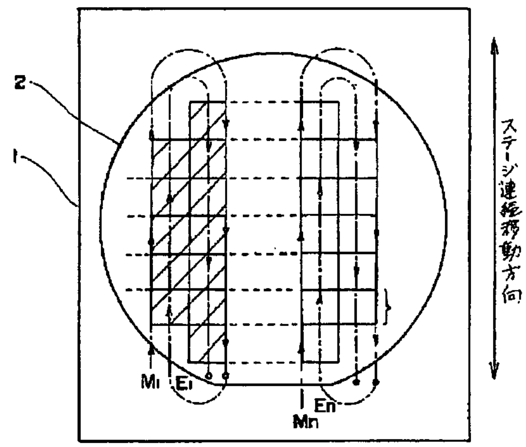
【図 11】



m1～mn…マーク検出位置

【図12】

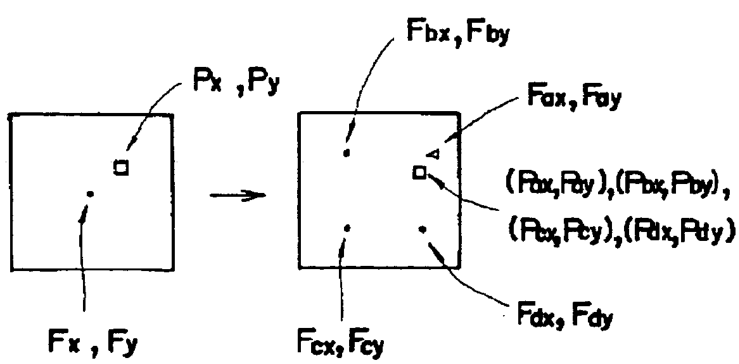
【図 12】



M1　マーク検出
E1　パターン描画

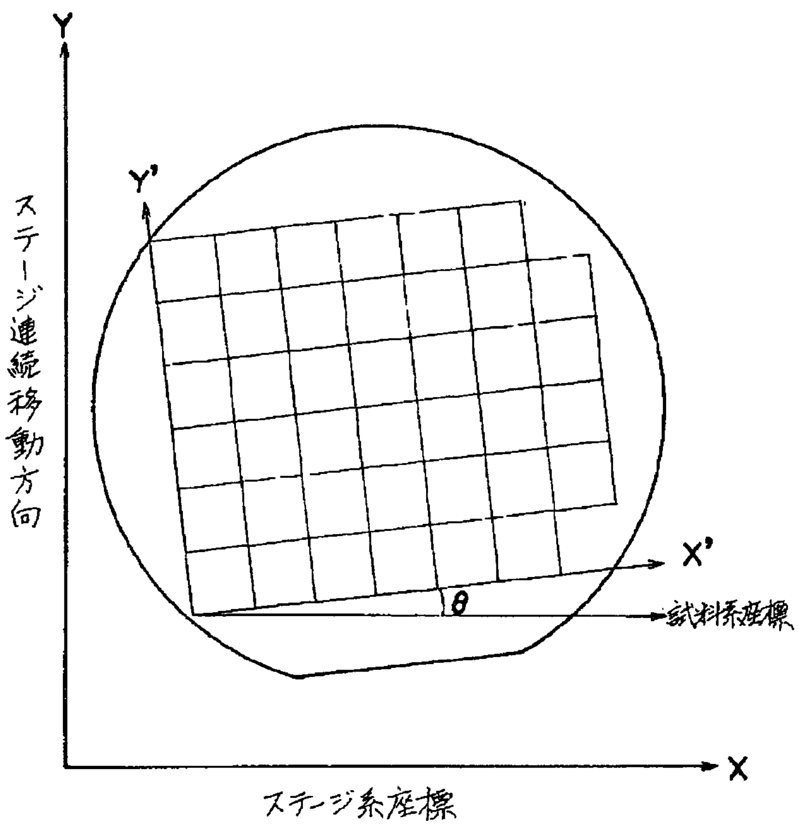
【図15】

【図 15】



【図13】

【図 13】



CLAIMS

[Claim(s)]
[Claim 1] Either [at least] the location of two or more alignment marks which scanned the semi-conductor wafer front face with the electron ray, and were formed on this wafer, or the height on the front face of a wafer is detected. The data which carried out **** detection are compared with the storage value according to which it was beforehand classified at least according to one side of the storage value or field internal division cloth beforehand classified according to the wafer condition in a data detection time. When it is judged that it has separated from the tolerance of distribution of the data with which the detected this data were memorized The electron-beam-lithography approach characterized by exposing the resist which read the above-mentioned storage value corresponding to this, replaced with these ****** data, corrected at least one of the configuration of the amount of deviations of an electron ray, and the photoelectron side of an electron ray, and the focal locations of an electron ray using this storage value, and was applied to the wafer front face.
[Claim 2] In the electron-beam-lithography approach which exposes the resist which applied the electron ray to this wafer and was applied on the wafer while moving the X-Y stage which carries a wafer to the one direction The exposure field of a wafer is divided into two or more exposure fields based on the electron ray swath width of the direction which intersects perpendicularly in the migration direction of a sample base with this. The electron-beam-lithography approach characterized by detecting either [at least] the location of the alignment mark formed in the wafer front face, or height for every termination of the exposure processing to one field of the divided this exposure field, and making the correction to a gap of alignment based on this detection result.
[Claim 3] The electron-beam-lithography approach characterized by being characterized by measuring the rotational error of the continuation migration direction of the X-Y stage which carries a wafer, and the axis of coordinates of the pattern formed on a wafer, and performing either [at least] correction of the amount of deviations of an electron ray, or angle-of-rotation revision of the configuration of the photoelectron side of an electron ray based on this rotational error.

[Claim 4] In the electron-beam-lithography approach which exposes a desired pattern on a wafer front face combining step migration in either [deviation control of an electron ray, and / at least] the direction of X of an X-Y stage where the wafer with which the resist was applied is carried in a front face, or the direction of Y A drawing field smaller than the range which can draw by the deviation exposure of the electron ray centering on a predetermined reference point is formed. The electron-beam-lithography approach characterized by forming at least two or more drawing reference points in this drawing field, aligning the above-mentioned predetermined reference point with these two or more drawing reference points one by one, and performing two or more electron-beam-lithography processings to the same pattern.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is used for the technique which imprints a circuit pattern etc. to the wafer with which it applied to the ultra-fine processing technology which used the electron ray for the semi-conductor manufacturing-technology pan, and the resist was especially applied to the front face, concerning an effective technique, and relates to a useful technique.
[0002]
[Description of the Prior Art] In performing the exposure process which imprints a desired integrated-circuit pattern to the wafer with which the resist was applied, in the production process of semiconductor integrated circuit equipment, the electron ray open opto-electronics which exposes this resist with an electron beam (electron ray) is well-known (for example, Kogyo Chosakai Publishing Co., Ltd., November 18, Showa 61 issue, 110th page - the 114th page of "electronic ingredient" November, 1986 issue separate volume). In this electron ray open opto-electronics, since an electron ray is irradiated on the wafer front face which applied the resist and direct writing of the integrated-circuit pattern is carried out, an integrated-circuit pattern more detailed than the conventional optical exposure technique (technique which once forms an integrated-circuit pattern in a photo mask, and imprints this on a wafer) can be formed.

[0003] therefore, drawing of the detailed integrated-circuit pattern by the electron ray -- efficiency -- oh, in order to close, when exact alignment of an electron ray and a sample is made into a premise and carries out computer control of the electron ray (focusing beam) based on the design data of an integrated circuit, a high speed and highly precise micro-processing processing are realizable.
[0004]
[Problem(s) to be Solved by the Invention] However, it was shown clearly by this invention persons for there to be the following problems in the technique mentioned above. That is, since distortion and a surface level difference arise to the wafer with which an integrated-circuit pattern is drawn while repeating many processes, it is required for it to amend in the graphic form (exposure graphic form) drawn by the electron ray according to this level difference, when maintaining the doubling precision and dimensional accuracy of the exposure graphic form piled up mutually after that. For this reason, to every [which is formed on a wafer] unit exposure field (refer to drawing 3), by the computer control of electron-beam-lithography equipment, predetermined amendment according to the above-mentioned level difference must be performed to each design data, and micro processing must be performed. However, when many processes are performed and a pattern puts on the substrate pattern on a semi-conductor wafer, during an activity, while repeating a process, distortion and a level difference arise on a wafer front face, or a foreign matter adheres to a wafer front face, or the defect on a mark arises on a wafer in the middle of a processing process, and there is a case where it becomes impossible to detect correctly the above-mentioned reference mark formed at the wafer. For this reason, even if it corrects alignment of a wafer and a circuit pattern based on a mark location detection value, the doubling error resulting from the detection error of a mark arises, and the fault referred to as that a high drawing precision is not acquired arises.
[0005] Moreover, it is known that the amount of fluctuation of the exposure location of the electron ray itself will become large gradually, so that it faces drawing a detailed pattern using an electron ray and irradiation time becomes long. In order to stop this, the exposure location is a desired location with the fixed time interval, or it is necessary to proofread based on the mark location on the mark on a stage, or a wafer. With the drawing equipment using an electron ray, in order to hold the rapidity of drawing processing, to shorten the time interval of the location detection of an alignment mark used as criteria and height detection as much as possible, and to proofread a location mark for a short period of time is desired. Moreover, while drawing a pattern completely on a wafer, it is necessary to perform proofreading processing two or more times, and to what kind of timing these processings are performed will determine the precision of drawing.
[0006] Moreover, when processing which draws a pattern on a wafer was performed carrying out continuation migration of the stage in which the wafer was carried in an one direction, it became clear that a rotation level difference arises by the direction of continuation migration of said stage, and the coordinate shaft orientation of the substrate pattern existing-formed on the wafer. The point which a maximum of about 500 micrometers of gaps of a coordinate produce according to this rotational error may exist. In order to amend this rotational error conventionally, the technique of carrying out minute rotation of the stage in which the wafer was carried by the rotational error was taken after error detection. However, rotation correction will become difficult if an electrostatic chuck method comes to be

adopted as a maintenance means of a wafer. Although this is fixing the wafer on a stage with static electricity by the electrostatic chuck method, holding power of this electrostatic chuck method cannot be positioned, in order to once be canceled and to make the rotation location within drawing equipment best, in case it moves to the vacua of drawing equipment from the interior of a room.

[0007] Moreover, when drawing a circuit pattern using an electron ray and an electron ray is irradiated by the sample (wafer), in case a sample is charged and a circuit pattern is drawn next with the charge at this time, the exposure location of an electron ray shifts from a desired location. The shift amount of this exposure location becomes large depending on the current value of an electron ray at the time of the drawing processing to which a current value becomes large, and in case it draws a circuit pattern with high precision, trouble produces it. Moreover, the deflection distortion of an electron ray becomes large and the boundary section (boundary section with a contiguity deviation field) of the deviation field which can draw by electron ray processing of 1 cannot draw high precision in this boundary section neighborhood. Furthermore, the electron ray itself affects it mutually between self charges according to Coulomb's law, a profile becomes not clear at the time of a drawing process, or dispersion arises in the dimension and location of a circuit pattern where fluctuation is drawn by the electron ray itself by being generated. Especially these troubles become remarkable at the circuit pattern drawing process of microscopic ** that high degree of accuracy is expected.

[0008] Accomplishing this invention in view of the above-mentioned situation, the 1st purpose is offering the electron-beam-lithography approach which lessened distorted effect of a wafer at the defect on said wafer, and the foreign matter list, and enabled high drawing of precision. Moreover, the 2nd purpose is offering the electron-beam-lithography approach of performing efficiently mark detection actuation and exposure actuation of an electron ray so that it may perform efficiently the drawing processing of a pattern and the proofreading processing of a location by the electron ray in the drawing equipment with which continuation migration of the stage is carried out. Moreover, the 3rd purpose is offering the electron-beam-lithography approach which made it possible to amend the rotational error of a wafer with a sufficient precision also in the drawing equipment with which the electrostatic chuck method was adopted. moreover, the wafer with which the electron ray with which the 4th purpose was irradiated was charged -- or it is offering the electron-beam-lithography equipment which it is accurate and can be drawn even if it is the case where the exposure location shifts, and the drawing approach with a self charge. It will become clear [about the other purposes and the new description] from description and the appending drawing of this specification along [said] this invention.

[0009]

[Means for Solving the Problem] It will be as follows if the outline of a typical thing is explained among invention indicated in this application. The drawing technique of this invention namely, when it applies to an electron-beam-lithography technique, [for example,] In order for the distortion on said sample, a defect, a foreign matter, etc. to protect detection precision degradation of the mark location on said sample side, and height on the occasion of detection of two or more alignment mark locations on a wafer, and height, Two or more detection data of said sample by statistics processing of the form of a sample, a production process, field internal division cloth, etc. The detection data which separated from distribution are excepted, the deviation of an electron ray (electric charge beam), formation of an electron ray, and the beam focal location of an electron ray are doubled using the remaining data, and a pattern is drawn to up to a sample. Moreover, in case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried, the drawing field on a wafer is divided in the continuation migration direction and the rectangular direction of said stage, and said mark location and detection of height, and pattern drawing are made to perform proofreading processing for every field with the amount of deviations of an electron ray (electric charge beam) repeatedly. Moreover, in case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried By measuring the rotational error of the direction of continuation migration of said stage, and the coordinate shaft orientation of the substrate pattern formed on the wafer, and adding amendment to the deflecting system of an electron ray, when said rotational error is small Moreover, when said rotational error is small, said rotational error is amended and it is made to draw by adding amendment to adding amendment to the deflecting system of an electron ray, and rotation of the configuration of an electron ray. Moreover, the dimension of the pattern which draws on a wafer in the approach of drawing a pattern to up to combination and a wafer, a position coordinate, etc. are changed into the coordinate centering on two or more reference points, and migration of a wafer, the deviation scan of an electron ray, and turning on and off of an electron ray are exposed in two or more [-fold] to one drawing point based on each coordinate.

[0010]

[Function] According to the electron-beam-lithography technique of above-mentioned this invention, on the occasion of detection of two or more alignment mark locations on a wafer, and height, the aforementioned detection data can

eliminate the thing reflecting the location and height of said sample, and the thing which included distortion of a sample in the defect on said sample side, and the foreign matter list by statistics processing of said detection data. For example, distribution of a mark location or height is searched for on a wafer based on deposition of the specific wiring film or an insulator layer, and distortion of the wafer after etching processing, and processing of removing the detection data which separated from this is attained. Moreover, in case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried, with the amount of drifts of an electron ray, without increasing drawing time amount sharply, by dividing the drawing field on a wafer in the continuation migration direction and the rectangular direction of said stage, pattern drawing can be carried out with detection of said mark location and height for every field, and improvement in precision can be aimed at. Moreover, in case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried By measuring the rotational error of the direction of continuation migration of said stage, and the coordinate shaft orientation of the substrate pattern formed on the wafer, and adding amendment to the deflecting system of an electron ray, when said rotational error is small Moreover, when said rotational error is large, said rotational error is amended and it is made to draw by adding amendment to the configuration of the photoelectron side of adding amendment to the deflecting system of an electron ray, and an electron ray at rotation. Moreover, to one kind of pattern data which specified the dimension of the pattern which draws migration of a wafer, the deviation scan of an electron ray, and turning on and off of an electron ray on a wafer in the approach of drawing a pattern on combination and a wafer, the position coordinate, etc., two or more coordinates centering on two or more reference points are acquired, and multiple-times pile exposure is carried out on the basis of this. Thereby, fluctuation of an electron ray is reduced and improvement in the connection precision in the electron ray deviation boundary section can be realized.

[0011]

[Example] Hereafter, one example of this invention is explained based on an accompanying drawing. The block diagram showing the configuration of the electron ray aligner which drawing 1 requires for this invention, the perspective view in which drawing 2 shows the configuration of electron beam equipment, The explanatory view in which drawing 3 shows an example of the relation between the array condition of the unit exposure field on a wafer, and an alignment mark, The explanatory view of data processing according [the statistics processing flow of mark detection data, drawing 5 , and drawing 6] to the field internal division cloth of a wafer in drawing 4 , The explanatory view having shown an example of the processing which asks for the deflection coefficient [drawing 10 / drawing 7 -] according to the height of the exposure side of an exposed object (wafer), The explanatory view showing an example of the criteria mark detection location at the time of drawing 11 asking for a deflection coefficient, The explanatory view of the drawing method according [drawing 12] to the electron ray aligner of this example, the explanatory view showing the rotational error from which drawing 13 is produced between the axis of coordinates of a wafer circuit pattern, and the migration direction of a stage, The explanatory view and drawing 15 which show the generation procedure of data in which drawing 14 uses the electron-beam-irradiation technique of the 2nd example are the explanatory view showing the procedure of electron beam irradiation based on the above-mentioned data.

[0012] (The 1st example) With reference to drawing 1 and drawing 2 , the drawing procedure by electron-beam-lithography equipment is explained first. The sample base shown by one in drawing consists of an X-Y stage which can move in the direction of X, and the direction (for example, the longitudinal direction and lengthwise direction of drawing 3) of Y freely in a horizontal plane, and the semi-conductor wafer 2 with which the admiration electron beam resist was put on the front face is laid as an exposed object (sample) on this sample base 1. The source 3 of an electron ray is formed above the sample base 1, and an electron ray 4 is irradiated towards the wafer 2 laid in the sample base 1. Between the source 3 of an electron ray, and the sample base 1, the electron ray adjusting device of the electron optics system which consists of the shaping machine 5, the rotation lens 6, deflecting system 7, an objective lens 8, etc. is formed.

[0013] After the photoelectron side was changed into the predetermined configuration (rectangle) by the aperture 5a and 5b (drawing 2) prepared in the interior when the electron ray 4 irradiated from said source 3 of an electron ray passed the shaping machine 5, Spin compensation with the rotation lens 6 and the deviation amendment by deflecting system 7 are made, and, thereby, an electron ray is irradiated by the location of the arbitration on a wafer (exposed object) 2 with the quantity of light of arbitration. And focusing to the front face of the exposed object 2 of the irradiated electron ray 4 is performed by said objective lens 8.

[0014] The Z measurement machine 23 which detects the reflected light of the electron ray 4 applied by the wafer 2, and measures the height of the incidence part of the electron ray 4 in a wafer 2 is formed in the upper part location of the exposed object 2 of said sample base 1. Moreover, the mark detection machine 24 which detects the secondary electron when irradiating said electron ray 4 or other light sources 21 at the mark formation section on the top face of a

sample or the scattered light 22, and detects the mark location of an exposed lifter based on this detection result is formed in the sample base 1 upper-part location. These Z measurement machines 23 and the mark detection machine 24 are connected to a control computer 16 by each, and the detection result is sent to this computer 16.

[0015] Said shaping machine 5 which changes a photoelectron side into a predetermined configuration is connected to the 1st buffer memory 25 and also control computer 16 in which rapid access is possible through the shaping machine control section 9 and the shaping signal generator 10, and the rotation lens 6 is connected to operation part 11, the 1st buffer memory 25, and a control computer 16 through the rotation lens control section 12. Moreover, the rotation lens control section 12 is connected to the 2nd buffer memory 25 and also a control computer 16. Moreover, deflecting system 7 is connected to said operation part 11 and 2nd buffer memory 25 through the deviation control section 14 and the deviation signal generator 15, respectively. On the other hand, the objective lens 8 is connected to operation part 11 and a control computer 16 through the objective lens control section 17 and the 2nd buffer memory 25. Moreover, the sample base control section 19 which controls actuation of the X-Y stage of the sample base 1 is connected to the control computer 16.

[0016] A lot of information about the graphic form exposed in the exposed object 2 is stored in the above-mentioned control computer 16, for example, the drawing data storage section 20 which consists of a hard disk drive unit of mass storage capacity etc. is connected to it. This drawing data storage section 20 is constituted so that the predetermined graphic form information chosen suitably may be transmitted to the 1st buffer memory 18 in which rapid access is possible if needed with a control computer 16. Moreover, the database 26 which stores the data about the mark location and height of the exposed object (wafer) 2 according to the field internal division cloth of a wafer the form (CMOSLSI, a bipolar large-scale integrated circuit, --) of a wafer and the exception of the production process to which the exposure concerned is performed is connected to said control computer 16. And this data is linked to the exposure job program corresponding to each wafer 2, and can be serially taken out now.

[0017] On the other hand, based on the graphic form information currently held at buffer memory 18, operation part 11 calculates configurations (rectangular magnitude etc.), the amount of deviations (electromagnetism controlled variable of polarization and electrostatic polarization), etc. of a photoelectron side of an electron ray 4, and outputs the various control signals according to these various results of an operation. The shaping signal generator 10 and the shaping machine control section 9 which received the control signal from this operation part 11 control the shaping machine 5 based on this signal (control of the configuration of a photoelectron side). Furthermore, the above-mentioned control signal is sent also to the rotation lens control section 12, the deviation signal generator 15, and the objective lens control section 17. Among these, said rotation lens control section 12 performs actuation control of the rotation lens 6, and the deviation signal generator 15 collaborates with the deviation control section 14, and controls deflecting system 7. And the objective lens control section 17 controls an objective lens 8 (focusing). In this case, between the control computer 16, the deviation signal generator 15 and a computer 16, the rotation lens control section 12, and a computer 16 and the objective lens control section 17, the 2nd buffer memory 25 (storage means) is interposed, and, as for this 2nd buffer memory 25, the height data from said Z measurement machine 23 are inputted.

[0018] And the detection results (height data) obtained with the above-mentioned Z measurement vessel 23 are the below-mentioned component fields P1 and P2. -- The exposure side height measured by detection is recognized for every (every field internal division cloth) deviation field of Pn (refer to drawing 3), and the correction factor of the arbitration beforehand stored in the 2nd buffer memory 25 according to this recognized height is read alternatively. Thus, the read correction factor is sent as a signal with which that is expressed to said deviation signal generator 15, the rotation lens control section 12, and the objective lens control section 17.

[0019] Drawing 2 is the perspective view showing the configuration of the drawing equipment of the above-mentioned electron beam equipment. On X-Y stage (sample base) 1 which can move freely, the wafer (exposed object) 1 with which the admiration electron beam resist etc. was applied is carried at the front face in the horizontal plane of the sample shown in drawing 2 . Above the sample base 1, the source slack electron gun 3 of an electron ray is formed, and it is constituted so that an electron ray 4 may be emitted towards a wafer 2. In the path of an electron ray 4 of reaching [from the source 3 of an electron ray] the sample base 1, the electron optics system which consists of the molding machine 5, the rotation lens 6, deflecting system 7, an objective lens 8, etc. is prepared, and an electron ray controller (equipment) is constituted.

[0020] The operations sequence of exposure of the wafer alignment / pattern using the electron-beam-lithography equipment of this configuration is concretely explained with reference to drawing 3 . The exposure sides of the semi-conductor wafer 2 are two or more component fields (unit exposure field) P1 and P2, as shown in drawing 3 . -- It is divided into Pn and they are each component fields P1 and P2. -- In the predetermined location of Pn, they are the alignment marks K1 and K2. -- Kn is prepared. This alignment mark is for maintaining two or more superposition

precision between circuit patterns used for every process at the exposure process repeated two or more times in case the component of an integrated circuit is formed for example, in a wafer front face (for alignment). In order to actually perform alignment using this alignment mark, an electron ray 4 or the light 22 from the light source 21 is applied to this alignment mark (K1, K2 -- Kn), the Z detector 23 or the mark detection machine 24 detects the scattered light at this time, and an alignment mark location is recognized in three dimension. And the data detected in this way are expressed as Li (xi, yi, zi), and these data Li distinguish with the flow chart which showed drawing 4 whether it was what reflected correctly the information on the alignment Ki formed on the wafer 2 (data of a mark formation way; ideal lattice point). Thus, by comparing the contents of data according to a flow chart, the detection error of the alignment mark produced when a foreign matter adheres on the exposed object (wafer) 2 or the substrate level difference has arisen is eliminated.

[0021] In this flow chart, two or more alignment marks (K1, K2 -- Kn) first prepared on the wafer at step 1 are measured, coordinate transformation of this measurement data is carried out at step 2, and Data Li (xi, yi, zi) are obtained. And error deltaLi with the ideal lattice point (value in a design stage) showing these profit ****** data Li and a mark is computed. [whether it has become below the reference value as which this error deltaLi is already determined at steps 3-6 by statistics processing for every form based on the detection data of ** past, and] ** It is distinguished, respectively whether it is within the limits determined [whether it has become below the reference value determined / whether it has become below the reference value determined for every production process and / for every ** lot and] for every field internal division cloth of ** wafer. In every form, the difference in the class (for example, a bipolar large-scale integrated circuit, CMOS--) of LSI formed in a wafer is said, and the difference among production processes, such as one layer of every process aluminum, an interlayer insulation film, and aluminum two-layer --, is said here. And when all of these distinction are "Yes", the data which adopt this data Li and express a new mark location and height with step 7 are computed. On the other hand, when it is "No" any of steps 3-6 they are, it is further distinguished at step 8 whether the error measurement ratio of K1-Kn is beyond a predetermined value (5%). An error measurement ratio is a ratio showing how many there was any mark from which the detection value separated from the above-mentioned reference value among all the marks (each mark shown in drawing 3) that detected data here. When this distinction result is "No", it returns to step 1, it redoes from detection of data, and on the other hand, at the time of "Yes", the data which separated from the above-mentioned reference value are replaced with the already memorized value (step 9), and subsequent processing is performed at it. In addition, it is data detected by the processing performed by then, and the thing used as the criteria of distinction of the above-mentioned steps S3-S6 classifies this data according to the form of an exposed object, a production process, a lot, and field internal division cloth, and memorizes it, and the detection data of the wafer corresponding to this classification condition are suitably read at the time of detection of new data, and let it be comparative criteria. By this method, if inspection of an exposed object is repeated, since many data will be stored so much, the precision of a criterion can be raised with time.

[0022] Next, based on the field internal division cloth of an exposed object (wafer), the procedure of performing exclusion of the abnormality data about the above-mentioned detection data Li and a supplement is explained using drawing 5 and drawing 6 . As shown in drawing 5 , when the data (Li+4) of an abnormality point are contained in the detection data Li, to error part deltaL from the ideal lattice point of each detection data, difference of the abnormality point data is carried out (Li+4), average-value processing of this is carried out, and this processed data is permuted by abnormality point data.

[0023] By the way, component fields P1 and P2 (unit exposure field) -- Focusing by control of the objective lens 8 according to the exposure side height of the ** this exposed object 2 (wafer) if the exposed object (wafer) 2 is hit performing exposure processing based on the graphic form information in the drawing data storage section 20 to Pn And the amendment (1st amendment) to the deflection coefficient of deflecting system 7, the component fields P1 and P2 on the object 2 exposed [**] -- The amendment (2nd amendment) to the deflection coefficient of the deflecting system 7 to distortion which the inequality of the system of coordinates of the system of coordinates which form Pn, and an electron optics system, and the exposed object 2 have is required. So, in this example, the following correction processings are performed after ending data processing mentioned above.

[0024] That is, calculation of the deflection coefficient of the deflecting system 7 according to the above-mentioned exposure side height and amendment to this are performed according to the following procedures. Amendment of height is performed if the exposure actuation to the exposed object 2 is preceded. In this case, first, the difference of height prepares the sample which has the known different high side 32 and the known different low side 31 on the sample base 1, and detects the location of the standard marks MH and ML of the high side 32 of a sample, and the low side 31. In this case, in detecting MH, as shown in drawing 7 and drawing 8 , the location of the sample base 1 is moved, the mark detection machine 24 (drawing 1) detects the secondary electron at the time of deflecting an electron

ray 4 and irradiating MH, and this obtains the standard mark MH detection result in a different deviation location. On the other hand, in detecting the standard mark ML, as shown in drawing 9 and drawing 10 , the standard mark ML is detected like the above in a different deviation location (moving the sample base 1). And by detecting the location of the standard marks MH and ML in two or more locations m1, m2, and m3 in a deviation field, and --mn (drawing 11), respectively, while only a predetermined distance moves the sample base 1 The amount of distortion according to change of exposure side height is calculated (it is assumed that the locations m1, m2, and m3 concerned and the data showing --mn are correctly called for in addition by the sample base control section 19 in this case based on the feed per revolution of the sample base 1 (X-Y stage)).

[0025] The deviation correction factor which should be given to the deviation signal generator 15 of drawing 1 is the coefficient A 0 which sets left part of the degree type (1) expressed and (2) to 0 when it considers as X, X of a deviation of Y, Y coordinate, and the amount of distortion that asked for delta X and delta Y from the location of the sample base 1, and A1. -- It is A9, and B0 and B1. -- It is B9.

deltaX=A0+A1 X+A2 Y+A3X2+A4XY+A5Y2+A6X3+A7X2 Y+A8XY2+A9 Y3 -- (1) deltaY=B0+B1X+B-2Y+B3X2+B4XY+B5Y2+B6X3+B7X2 Y+B8XY2+B9Y3 -- (2) [0026] Moreover, the deviation correction factors AnZ and BnZ in sample side height Z of arbitration If the number of deviation assistant Masakazu which had applied the data of the standard mark MH to the above (1) and (2) types, and asked for them among the standard marks shown in drawing 7 - drawing 10 is set to AnH and BnH and the deviation correction factor for which it asked using the standard mark ML is set to AnL and BnL AnZ=(AnH-AnL) Z/H --(3) BnZ=(BnH-BnL) Z/H It is given as --(4) (H is the difference of the height of the standard marks MH and ML here).

[0027] On the other hand, about an objective lens 8, amendment to a focal location and astigmatism is performed. The current value Ir of the focal amendment in this case becomes settled according to the deviation coordinates X and Y, and is calculated by the degree type (5).

Ir=alpha 0+alpha1 X+alpha 2 Y+alpha 3X2+alpha4 XY+alpha 5Y2+alpha6X3+alpha7X2 Y+alpha 8XY2+alpha9Y3 -- (5) alpha 0 changes according to sample side height Z, and is calculated by the degree type (6) here.

alpha0 Z=alpha 0L+(alpha0H-alpha0L)/H-Z -- (6) [0028] Moreover, the current value ISX of astigmatism correction is ISX=beta 0+beta1 X+beta 2 Y+beta 3X2+beta4 XY+beta 5Y2+beta6X3+beta7X2 Y+beta 8XY2+beta9Y3 ISY=gamma 0+gamma1 X+gamma 2 Y+gamma 3X2+gamma4 XY+gamma 5Y2+gamma6X3+gamma7X2 Y+gamma 8XY2+gamma9Y3 similarly. -- It is given as (7). beta0 and gamma0 are beta0Z=beta0L+(beta0H-beta0L) Z/as a function of Z here. -- (8) gamma0 Z=gamma 0L+(gamma0H-gamma0L) Z/H -- It is given as (9).

[0029] The correction factor Anz (A1Z, A2Z .... A9Z) which changes according to the height of a sample side in the electron ray aligner of this example, It is related with Bnz (B1Z, B-2Z....B9Z) and alpha0Z, beta0Z, and gamma0Z. ** Divide proportionally sample side height also including the difference of elevation H for said quantity, and low the 2nd page, or its outside. ** gamma1, gamma2 which were beforehand computed in each sample side height Z1, Z2, and Z3 and the value corresponding to --Zn .... gamma3, beta1, beta2 .. It stores in said 2nd buffer memory 25 with beta 3 (constant value). ** They are each alignment blocks K1 and K2 further.... Correction factor C0i for the alignment for every exposure field computed to every Km (refer to drawing 3), C1i, C2i, C3i, D0i, D1i, D2i, and D3i are stored in said 2nd buffer memory 25. ** They are each component fields P1 and P2 based on this. -- the correction factor for which it depends on exposure side height Z for each [corresponding to Pn] exposure field of every It chooses from the value beforehand stored in the 2nd buffer memory 25 according to measured exposure side height Z. ** Give directly to the deviation signal generator 15, the rotation lens control section 12, and the objective lens control section 17, without reading from the 2nd buffer memory 25 concerned, and making a control computer 16 intervene with what takes a fixed value. By this procedure, the exposure activity of each unit exposure field is done.

[0030] Data concerning an exposed object (wafer) to the control computer 16 of an electron ray aligner, Namely, the database 26 which has the information on the class of wafer, a production process, a groundbreaking lot, field internal division cloth, etc. is connected. By linking these data to the job data for exposure control of an exposed object, enabling it to take them out, and distinguishing mark detection data with a still more nearly actual exposed object based on these data taken out picking according to the flow shown in above-mentioned drawing 4 The superposition precision of the exposure to an exposed object can be raised certainly.

[0031] Drawing 12 is the explanatory view showing an example of the drawing method by the above-mentioned electron ray aligner. By this drawing method, continuation migration of X-Y stage (sample base) 1 of electron-beam-lithography equipment (drawing 2) is carried out only in the direction (the drawing 12 Nakagami down) of Y. This is because improvement in functional of the whole equipment (expansion-izing) must be aimed at to consider as the configuration which makes X-Y both directions carry out continuation migration of this stage by an X-Y stage's being constituted from the above-mentioned drawing equipment by the quality of the materials other than a metal (product

made from a ceramic) in order to prevent an overcurrent, and the weight of a stage becoming large in this case.

[0032] In carrying out the drawing method which carries out continuation migration only of the one direction (the direction of Y), vertical division of the exposure side of a wafer 2 is carried out in the continuation migration direction (drawing Nakagami down) and the rectangular direction of a stage, two or more drawing fields are formed, the drawing actuation to each drawing field is carried out as 1 actuation unit, and control (exposure) is performed. In addition, the above-mentioned drawing field which the beam arrangement has become fixed [the operating time in which continuation drawing is possible] in one actuation, therefore was set up as 1 actuation unit is set as a field smaller than the range which can sufficiently draw in the above-mentioned operating time. And the location detection of a mark (alignment mark) and mark height detection on a wafer are performed for every 1 actuation unit termination. And after that, the next drawing actuation is performed and processing of these single strings is repeated. In this case, between mark detection and drawing actuation, step migration of X-Y stage 1 is carried out in that continuation migration direction and rectangular direction, and mark detection and pattern drawing actuation in the field concerned are performed repeatedly by turns. In addition, in this example, actuation (drawing/proofreading) from M1 point to E1 point is made into 1 actuation unit, and, as for the drawing field (field shown with the slash in drawing 12), that breadth (width of face of the stage migration direction and the direction which intersects perpendicularly) is determined by the amount of drifts (two grids of drawing 4) twice the width of face of an electron ray.

[0033] Detection of the above-mentioned alignment mark (alignment) irradiates an electron ray at the mark section (formed in the DISUKURAIBU field of a wafer) of a sample, and is performed by detecting a reflection electron (or secondary electron) with the mark detection vessel 24 shown in drawing 1 (in accordance with the path M1 shown with the dashed line in drawing, mark detection is performed first). The mark location data detected with the mark detection vessel 4 are kept by the database (mark location data storage section) 26 shown in drawing 1 . Since the location precision of a drawing pattern will deteriorate if the relative position of the electron ray and sample (wafer) 2 which draw in that case carries out a drift, by this drawing method, amendment (proofreading processing) to the drift of the relative position of an electron ray 4 and a sample (wafer) 2 is performed for every fixed time amount progress.

[0034] Since an alignment mark (alignment mark) K1 and K2 -- are formed in the periphery of the DISUKURAIBU field of a wafer 2 as shown in drawing 3 , detection of an alignment mark and detection of a drawing mark are not made as for them to coincidence. Then, mark detection of the field is performed for every divided field, and it is made to draw the circuit pattern in the field concerned after that (carried out in accordance with the path E1 shown according to the two-dot chain line in drawing). By this drawing method, stage transit time which is processing for every drawing field by which the wafer was divided, and a change with mark location detection processing and drawing processing takes mark location detection processing and drawing processing by this can be lessened. As a result, amendment of gap with an electron ray 4 and a sample (wafer) 2 is performed efficiently, and the drawing precision of the circuit pattern to a wafer top improves further.

[0035] Drawing 13 shows typically the continuation migration direction of a stage, and the mechanical rotational error of the pattern on a wafer. if the mechanical rotational error of the pattern on a wafer is not managed in a semi-conductor production line -- a location -- a maximum of 500 -- an about [micrometer/100mm] coordinate shifts. Therefore, by the drawing method of this example, the angle-of-rotation difference theta (drawing 13) with the axis of coordinates (X-axis) of the substrate pattern in which these errors were formed on the axis of coordinates (for example, X-axis) of the X-Y migration direction of a stage and the wafer 2 is measured, a rotational error is amended at the drawing point F of arbitration (x y) based on this measurement value theta, and the coordinate P after correction (x y) is acquired. In addition, in measuring the detection value theta, it is measured by detecting two alignment marks formed in the wafer front face at least, and comparing these mutually.

[0036] This rotational error theta degrades the location precision of a drawing pattern. A big level difference arises in the join of rectangular photoelectron sides, and when it is going to draw a straight line, this is because each photoelectron side is located in a line stair-like and a level difference arises temporarily, as a rotational error theta becomes large, since the photoelectron side of the rectangle formed in drawing by the electron ray of the aperture shown in drawing 2 is put in order continuously and a desired pattern is formed. In this example, when small, only by adding amendment to the deflecting system of an electron ray 4, this rotational error is amended (an amended part of the above-mentioned rotational error is added to the deflecting system 7 of drawing 1), it adds amendment to the rotation lens 6 of an electron ray, and a value theta amends this rotational error in the configuration (rectangle) of a photoelectron side itself, while theta performs amendment by said deflecting system 7, when large. Angle correction is made and a level difference stops thus, arising in the graphic form (pattern) which put the photoelectron side concerned in order continuously to the system of coordinates which the rotational error produced [the rectangular photoelectron side] by carrying out amendment according to a rotational error to the photoelectron side itself. Thus, the drawing

precision of a pattern can always be highly held by performing amendment according to a rotational error irrespective of the mechanical rotational error theta of the continuation migration direction (the inside X of drawing, the direction of Y) of a stage, and the pattern on a wafer (x in the coordinate on a wafer, and drawing, the direction of y).

[0037] (The 2nd example) In drawing using the electron beam equipment of drawing 2 , drawing 14 is the explanatory view showing the technique of conversion of the drawing data (system of coordinates of exposure) in the drawing method (drawing method of the 2nd example) which the sample base (X-Y stage) 1 of drawing equipment makes carry out step migration in the direction of X-Y. By this drawing method, in order to specify the drawing field (coordinate point of exposure) which draws on a wafer, four normal coordinates (Fx+delta, Fy+delta), (Fx-delta and Fy+delta), (Fx-delta and Fy-delta), and (Fx+delta and Fy-delta) are first set up focusing on the coordinate (Fx, Fy) in the field by the side of drawing equipment (unit exposure field), and this. The case where the predetermined pattern coordinate (Px, Py) on the basis of a coordinate (Fx, Fy) is drawn is considered temporarily now. In this case, four modification coordinates of the above-mentioned pattern coordinate (Px, Py) consisting mainly of four normal coordinates (Fx+delta, Fy+delta), (Fx-delta and Fy+delta), (Fx-delta and Fy-delta), and (Fx+delta and Fy-delta) are searched for first. In this case, four coordinates serve as (Px-delta, Py-delta), (Px+delta and Py-delta), (P+xdelta and Py+delta), and (Px-delta and Py+delta). And superposition of four drawing processings is performed based on four kinds of each pattern data (coordinate) of this. In addition, if it hits actually drawing, four changed pattern coordinates will be computed to many pattern coordinates, respectively. When data [of drawing 14] (a) - (d) shifts ** coordinate (Fx, Fy) in the direction of X, and the direction of Y only for predetermined movement magnitude +delta (Fx+delta, Fy+delta), ** In the direction of X - In delta and the direction of Y, +delta shift When carrying out (Fx-delta, Fy+delta), ** When -delta shift of is made to do in the direction of X in +delta and the direction of Y (Fx-delta, Fy-delta), the value after conversion of the pattern data (coordinate) after the shift to the original pattern data (Px, Py) at the time of doing -delta shift of (Fx+delta, Fy-delta) is shown in both the direction of **X, and the direction of Y. In this example, the coordinate (Px, Py) of the part and pattern data which the shift direction of the main coordinate (Fx, Fy) of the field moved is shifted to an opposite direction, and the drawing data with which only a part for the field coordinate to have done **delta shift of shifts are corrected to an opposite direction. In order that this may perform superposition of at least four drawing processings in the drawing range concerned, he is trying for the drawing point after one migration to surely exist in drawing within the limits, although above-mentioned shift-amount delta makes the direction of X, and the direction of Y 1/2 or less [of the sum total (range which can be drawn) of the maximum electromagnetic deflection width of face of electron-beam-lithography equipment, and the maximum electrostatic deflection width of face].

[0038] Drawing 15 is what showed the above-mentioned drawing method typically. A shift amount **delta shift in X and the direction of Y in the one field (unit exposure field) Four normal coordinates carried out (Fx, Fy), (Fax, Fay), (Fbx, Fby), (Fcx, Fcy), and (Fdx, Fdy) are prepared, and it is expressed as a coordinate from which the drawing point (Px, Py) of 1 differed on the basis of each coordinate. And four drawing processings which centered on the four above-mentioned normal coordinates, respectively will be performed in piles.

[0039] By this drawing method, deviation control is performed combining the deviation of an electron ray, and ON/OFF of an electron ray. The deviation of an electron ray 4 is performed by putting an electromagnetic deflection and an electrostatic deflection together (an electromagnetic deflection is maximum beam deflection width of face of about 5mm, and an electrostatic deflection is the electron ray scan width of about 50-500 micrometers). Therefore, the range which can draw the drawing equipment concerned in the condition that the X-Y stage was fixed serves as the sum of these two scan width. Therefore, if the electromagnetic deflection width of face of an electron ray 4, electrostatic deflection width of face, and the sum shift the movement magnitude (shift-amount delta) of said X-Y stage 1/2 as mentioned above in exposing in 4 times of piles to one pattern data, exposure of a pile will be performed efficiently 4 times. Thus, when 4 times of exposure processes are given to the drawing field of 1, the obscuration of an electron ray 4 is equalized in the boundary section of the fluctuation, especially the drawing fields of an electron ray 4, and an accurate exposure is attained.

[0040] As explained above, in order for the distortion on said sample, a defect, a foreign matter, etc. to protect detection precision degradation of the mark location on said sample side, and height in this example on the occasion of detection of two or more alignment mark locations on a wafer, and height, Two or more detection data of said sample by statistics processing of the form of a sample, a production process, field internal division cloth, etc. Since the detection data which separated from distribution are excepted, the deviation of an electron ray (electric charge beam), formation of an electron ray, and the beam focal location of an electron ray are doubled using the remaining data and the pattern was drawn to up to the sample On the occasion of detection of two or more alignment mark locations on a wafer, and height, the aforementioned detection data can judge the thing reflecting the location and height of said sample, and the thing which included distortion of a sample in the defect on said sample side, and the foreign matter

list, and can eliminate this. In case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried, moreover, with the amount of deviations of an electron ray (electric charge beam) Since the drawing field on a wafer is divided in the continuation migration direction and the rectangular direction of said stage and said mark location and detection of height, and pattern drawing were made to perform proofreading processing repeatedly for every field, proofreading processing can be performed without increasing drawing time amount sharply. Moreover, in case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried By measuring the rotational error of the direction of continuation migration of said stage, and the coordinate shaft orientation of the substrate pattern formed on the wafer, and adding amendment to the deflecting system of an electron ray, when said rotational error is small Moreover, when said rotational error is small, by adding amendment to adding amendment to the deflecting system of an electron ray, and rotation of the configuration of an electron ray, said rotational error is amended and high drawing of precision is performed. Moreover, migration of a wafer, the deviation scan of an electron ray, and turning on and off of an electron ray are set to the approach of drawing a pattern to up to combination and a wafer. Since the dimension of the pattern which draws on a wafer, the position coordinate, etc. were changed into the coordinate centering on two or more reference points and it exposed in two or more [-fold] to one drawing point based on each coordinate, fluctuation of an electron ray is reduced and improvement in the connection precision in the electron ray deviation boundary section can be realized.

[0041]

[Effect of the Invention] It will be as follows if the effectiveness acquired by the typical thing among invention indicated in this application is explained briefly. That is, even if it is the case where a defect, a foreign matter, and distortion arise on a wafer front face, high drawing processing of precision can be performed. Moreover, since drawing processing and proofreading processing of a wafer can be performed efficiently, processing speed becomes quick as the whole drawing processing, and effectiveness of operation is raised. Moreover, even if it is the case where the rotational error of the direction of continuation migration of an X-Y stage and the coordinate shaft orientation of the substrate pattern formed on the wafer arises, this can be amended and high drawing of precision can be performed. Since heavy exposure of multiple times is performed to the drawing point of 1, fluctuation of an electron ray is reduced and the drawing precision in the electron ray deviation boundary section is raised.

[Translation done.]

.TECHNICAL FIELD

[Industrial Application] This invention is used for the technique which imprints a circuit pattern etc. to the wafer with which it applied to the ultra-fine processing technology which used the electron ray for the semi-conductor manufacturing-technology pan, and the resist was especially applied to the front face, concerning an effective technique, and relates to a useful technique.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In performing the exposure process which imprints a desired integrated-circuit pattern to the wafer with which the resist was applied, in the production process of semiconductor integrated circuit equipment, the electron ray open opto-electronics which exposes this resist with an electron beam (electron ray) is well-known (for example, Kogyo Chosakai Publishing Co., Ltd., November 18, Showa 61 issue, 110th page - the 114th page of "electronic ingredient" November, 1986 issue separate volume). In order to irradiate an electron ray in this electron ray open opto-electronics on the wafer front face which applied the resist and to carry out direct writing of the integrated-circuit pattern, it is the conventional optical exposure technique.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] It will be as follows if the effectiveness acquired by the typical thing among invention indicated in this application is explained briefly. That is, even if it is the case where a defect, a foreign matter, and distortion arise on a wafer front face, high drawing processing of precision can be performed. Moreover, since drawing processing and proofreading processing of a wafer can be performed efficiently, processing speed becomes quick as the whole drawing processing, and effectiveness of operation is raised. Moreover, even if it is the case where the rotational error of the direction of continuation migration of an X-Y stage and the coordinate shaft orientation of the substrate pattern formed on the wafer arises, this can be amended and high drawing of precision can be performed. Since heavy exposure of multiple times is performed to the drawing point of 1, fluctuation of an electron ray is reduced and the drawing precision in the electron ray deviation boundary section is raised.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, it was shown clearly by this invention persons for there to be the following problems in the technique mentioned above. That is, since distortion and a surface level difference arise to the wafer with which an integrated-circuit pattern is drawn while repeating many processes, it is required for it to amend in the graphic form (exposure graphic form) drawn by the electron ray according to this level difference, when maintaining the doubling precision and dimensional accuracy of the exposure graphic form piled up mutually after that. For this reason, to every [which is formed on a wafer] unit exposure field (refer to drawing 3), by the computer control of electron-beam-lithography equipment, predetermined amendment according to the above-mentioned level difference must be performed to each design data, and micro processing must be performed. However, when many processes are performed and a pattern puts on the substrate pattern on a semi-conductor wafer, during an activity, while repeating a process, distortion and a level difference arise on a wafer front face, or a foreign matter adheres to a wafer front face, or the defect on a mark arises on a wafer in the middle of a processing process, and there is a case where it becomes impossible to detect correctly the above-mentioned reference mark formed at the wafer. For this reason, even if it corrects alignment of a wafer and a circuit pattern based on a mark location detection value, the doubling error resulting from the detection error of a mark arises, and the fault referred to as that a high drawing precision is not acquired arises.

[0005] Moreover, it is known that the amount of fluctuation of the exposure location of the electron ray itself will become large gradually, so that it faces drawing a detailed pattern using an electron ray and irradiation time becomes long. In order to stop this, the exposure location is a desired location with the fixed time interval, or it is necessary to proofread based on the mark location on the mark on a stage, or a wafer. With the drawing equipment using an electron ray, in order to hold the rapidity of drawing processing, to shorten the time interval of the location detection of an alignment mark used as criteria and height detection as much as possible, and to proofread a location mark for a short period of time is desired. Moreover, while drawing a pattern completely on a wafer, it is necessary to perform proofreading processing two or more times, and to what kind of timing these processings are performed will determine the precision of drawing.

[0006] Moreover, when processing which draws a pattern on a wafer was performed carrying out continuation migration of the stage in which the wafer was carried in an one direction, it became clear that a rotation level difference arises by the direction of continuation migration of said stage, and the coordinate shaft orientation of the substrate pattern existing-formed on the wafer. The point which a maximum of about 500 micrometers of gaps of a coordinate produce according to this rotational error may exist. In order to amend this rotational error conventionally, the technique of carrying out minute rotation of the stage in which the wafer was carried by the rotational error was taken after error detection. However, rotation correction will become difficult if an electrostatic chuck method comes to be adopted as a maintenance means of a wafer. Although this is fixing the wafer on a stage with static electricity by the electrostatic chuck method, holding power of this electrostatic chuck method cannot be positioned, in order to once be canceled and to make the rotation location within drawing equipment best, in case it moves to the vacua of drawing equipment from the interior of a room.

[0007] Moreover, when drawing a circuit pattern using an electron ray and an electron ray is irradiated by the sample (wafer), in case a sample is charged and a circuit pattern is drawn next with the charge at this time, the exposure location of an electron ray shifts from a desired location. The shift amount of this exposure location becomes large depending on the current value of an electron ray at the time of the drawing processing to which a current value becomes large, and in case it draws a circuit pattern with high precision, trouble produces it. Moreover, the deflection distortion of an electron ray becomes large and the boundary section (boundary section with a contiguity deviation field) of the deviation field which can draw by electron ray processing of 1 cannot draw high precision in this boundary

section neighborhood. Furthermore, the electron ray itself affects it mutually between self charges according to Coulomb's law, a profile becomes not clear at the time of a drawing process, or dispersion arises in the dimension and location of a circuit pattern where fluctuation is drawn by the electron ray itself by being generated. Especially these troubles become remarkable at the circuit pattern drawing process of microscopic ** that high degree of accuracy is expected.

[0008] Accomplishing this invention in view of the above-mentioned situation, the 1st purpose is offering the electron-beam-lithography approach which lessened distorted effect of a wafer at the defect on said wafer, and the foreign matter list, and enabled high drawing of precision. Moreover, the 2nd purpose is offering the electron-beam-lithography approach of performing efficiently mark detection actuation and exposure actuation of an electron ray so that it may perform efficiently the drawing processing of a pattern and the proofreading processing of a location by the electron ray in the drawing equipment with which continuation migration of the stage is carried out. Moreover, the 3rd purpose is offering the electron-beam-lithography approach which made it possible to amend the rotational error of a wafer with a sufficient precision also in the drawing equipment with which the electrostatic chuck method was adopted. moreover, the wafer with which the electron ray with which the 4th purpose was irradiated was charged -- or it is offering the electron-beam-lithography equipment which it is accurate and can be drawn even if it is the case where the exposure location shifts, and the drawing approach with a self charge. It will become clear [about the other purposes and the new description] from description and the appending drawing of this specification along [said] this invention.

[Translation done.]

MEANS

[Means for Solving the Problem] It will be as follows if the outline of a typical thing is explained among invention indicated in this application. The drawing technique of this invention namely, when it applies to an electron-beam-lithography technique, [for example,] In order for the distortion on said sample, a defect, a foreign matter, etc. to protect detection precision degradation of the mark location on said sample side, and height on the occasion of detection of two or more alignment mark locations on a wafer, and height, Two or more detection data of said sample by statistics processing of the form of a sample, a production process, field internal division cloth, etc. The detection data which separated from distribution are excepted, the deviation of an electron ray (electric charge beam), formation of an electron ray, and the beam focal location of an electron ray are doubled using the remaining data, and a pattern is drawn to up to a sample. Moreover, in case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried, the drawing field on a wafer is divided in the continuation migration direction and the rectangular direction of said stage, and said mark location and detection of height, and pattern drawing are made to perform proofreading processing for every field with the amount of deviations of an electron ray (electric charge beam) repeatedly. Moreover, in case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried By measuring the rotational error of the direction of continuation migration of said stage, and the coordinate shaft orientation of the substrate pattern formed on the wafer, and adding amendment to the deflecting system of an electron ray, when said rotational error is small Moreover, when said rotational error is small, said rotational error is amended and it is made to draw by adding amendment to adding amendment to the deflecting system of an electron ray, and rotation of the configuration of an electron ray. Moreover, the dimension of the pattern which draws on a wafer in the approach of drawing a pattern to up to combination and a wafer, a position coordinate, etc. are changed into the coordinate centering on two or more reference points, and migration of a wafer, the deviation scan of an electron ray, and turning on and off of an electron ray are exposed in two or more [-fold] to one drawing point based on each coordinate.

[Translation done.]

OPERATION

[Function] According to the electron-beam-lithography technique of above-mentioned this invention, on the occasion of detection of two or more alignment mark locations on a wafer, and height, the aforementioned detection data can eliminate the thing reflecting the location and height of said sample, and the thing which included distortion of a sample in the defect on said sample side, and the foreign matter list by statistics processing of said detection data. For example, distribution of a mark location or height is searched for on a wafer based on deposition of the specific wiring film or an insulator layer, and distortion of the wafer after etching processing, and processing of removing the detection data which separated from this is attained. Moreover, in case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried, with the amount of drifts of an electron ray, without increasing drawing time amount sharply, by dividing the drawing field on a wafer in the continuation migration direction and the rectangular direction of said stage, pattern drawing can be carried out with detection of said mark location and height for every field, and improvement in precision can be aimed at. Moreover, in case a pattern is drawn on a wafer, moving continuously on the stage in which the wafer was carried By measuring the rotational error of the direction of continuation migration of said stage, and the coordinate shaft orientation of the substrate pattern formed on the wafer, and adding amendment to the deflecting system of an electron ray, when said rotational error is small Moreover, when said rotational error is large, it is the thing amends said rotational error and it was made to draw by adding amendment to the configuration of the photoelectron side of adding amendment to the deflecting system of an electron ray, and an electron ray at rotation. It is. Moreover, to one kind of pattern data which specified the dimension of the pattern which draws migration of a wafer, the deviation scan of an electron ray, and turning on and off of an electron ray on a wafer in the approach of drawing a pattern on combination and a wafer, the position coordinate, etc., two or more coordinates centering on two or more reference points are acquired, and multiple-times pile exposure is carried out on the basis of this. Thereby, fluctuation of an electron ray is reduced and improvement in the connection precision in the electron ray deviation boundary section can be realized.

[Translation done.]

EXAMPLE

[Example] Hereafter, one example of this invention is explained based on an accompanying drawing. The block diagram showing the configuration of the electron ray aligner which drawing 1 requires for this invention, the perspective view in which drawing 2 shows the configuration of electron beam equipment, The explanatory view in which drawing 3 shows an example of the relation between the array condition of the unit exposure field on a wafer, and an alignment mark, The explanatory view of data processing according [the statistics processing flow of mark detection data, drawing 5 , and drawing 6] to the field internal division cloth of a wafer in drawing 4 , The explanatory view having shown an example of the processing which asks for the deflection coefficient [drawing 10 / drawing 7 -] according to the height of the exposure side of an exposed object (wafer), The explanatory view showing an example of the criteria mark detection location at the time of drawing 11 asking for a deflection coefficient, The explanatory view of the drawing method according [drawing 12] to the electron ray aligner of this example, the explanatory view showing the rotational error from which drawing 13 is produced between the axis of coordinates of a wafer circuit pattern, and the migration direction of a stage, The explanatory view and drawing 15 which show the generation procedure of data in which drawing 14 uses the electron-beam-irradiation technique of the 2nd example are the explanatory view showing the procedure of electron beam irradiation based on the above-mentioned data.

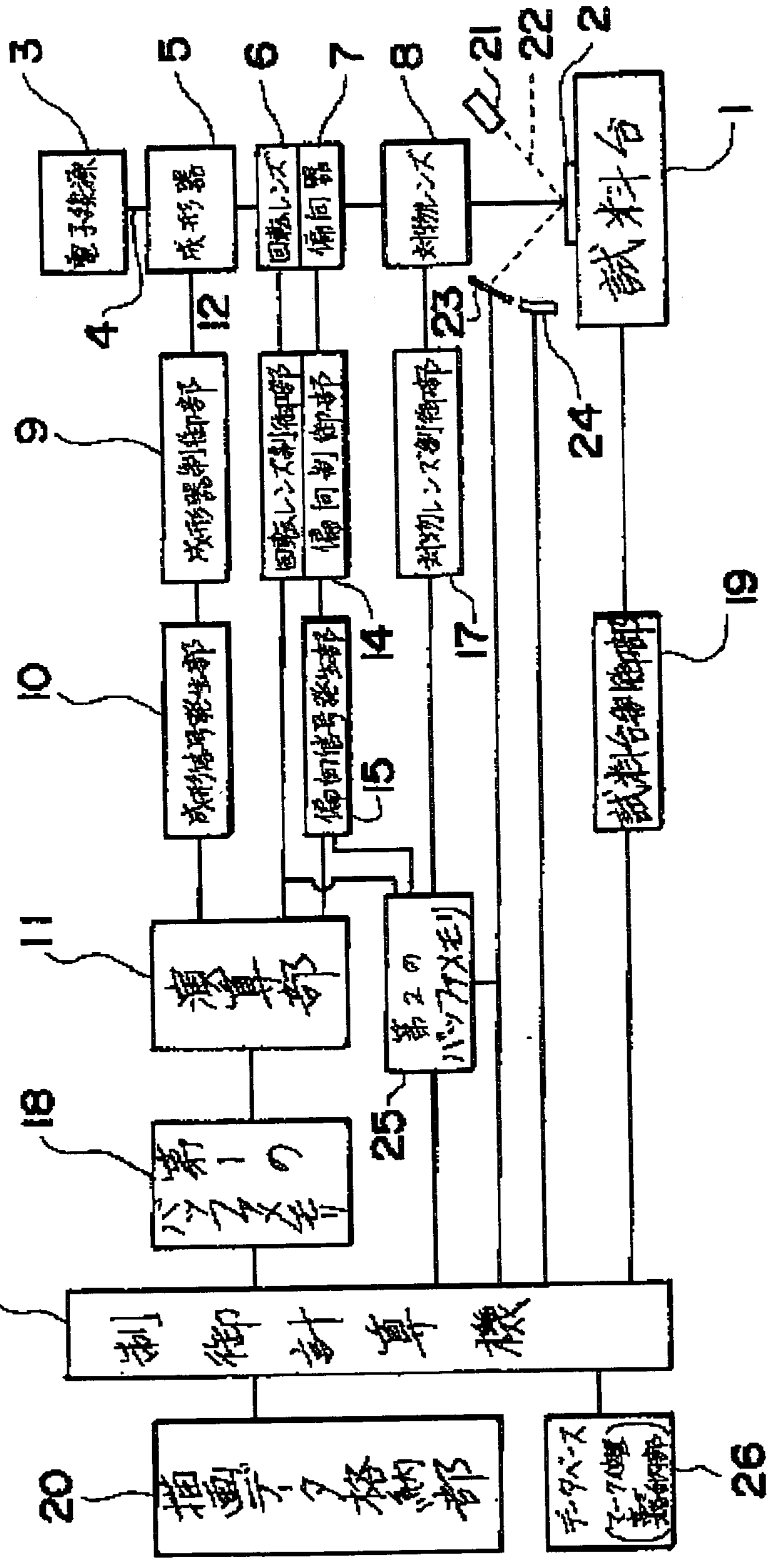
[Translation done.]

DESCRIPTION OF DRAWINGS

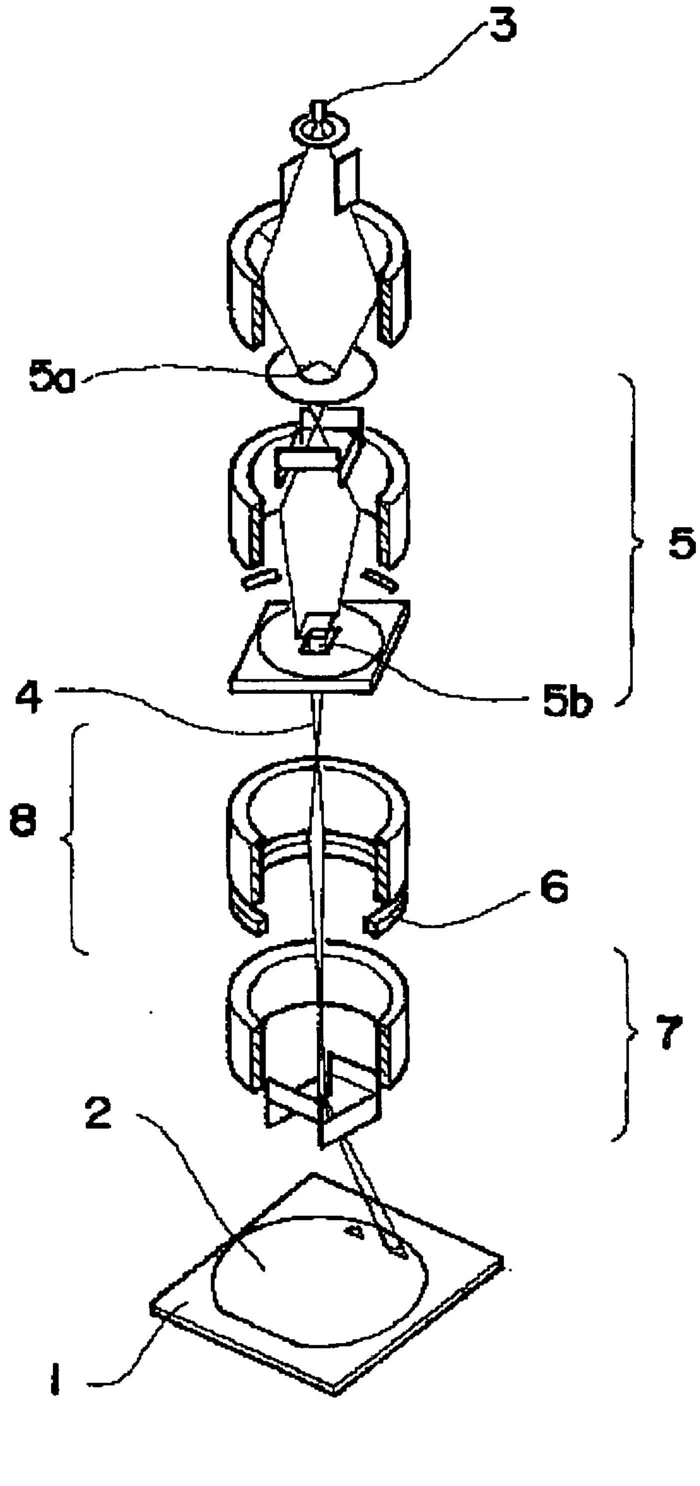
[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the configuration of the electron ray aligner concerning this invention.
[Drawing 2] It is the perspective view showing the configuration of electron beam equipment.
[Drawing 3] It is the explanatory view showing an example of the relation between the array condition of the unit exposure field on a wafer, and an alignment mark.
[Drawing 4] It is the statistics processing flow chart of mark detection data.
[Drawing 5] It is the explanatory view of data processing by the field internal division cloth of a wafer.
[Drawing 6] It is the explanatory view of data processing by the field internal division cloth of a wafer.
[Drawing 7] It is the explanatory view having shown an example of the technique of asking for the deflection coefficient according to the height of the exposure side of an exposed object (wafer).
[Drawing 8] It is the explanatory view having shown an example of the technique of asking for the deflection coefficient according to the height of the exposure side of an exposed object (wafer).
[Drawing 9] It is the explanatory view having shown an example of the technique of asking for the deflection coefficient according to the height of the exposure side of an exposed object (wafer).
[Drawing 10] It is the explanatory view having shown an example of the technique of asking for the deflection coefficient according to the height of the exposure side of an exposed object (wafer).
[Drawing 11] It is the explanatory view showing an example of the criteria mark detection location at the time of asking for a deflection coefficient.
[Drawing 12] It is the explanatory view of the drawing method by the electron ray aligner of this example.
[Drawing 13] It is the explanatory view showing the rotational error produced between the axis of coordinates of a wafer circuit pattern, and the migration direction of a stage.
[Drawing 14] It is the explanatory view showing the generation procedure of the data used in case the electron-beam-irradiation technique of the 2nd example is performed.
[Drawing 15] It is the explanatory view showing the procedure of electron beam irradiation based on the data shown in drawing 14 .
[Description of Notations]
1 Sample Base (X-Y Stage)
2 Wafer
4 Electron Ray
6 Rotation Lens
7 Deflecting System
8 Objective Lens
12 Rotation Lens Control Section
14 Deviation Control Section
16 Control Computer
17 Objective Lens Control Section
20 Drawing Data Storage Section
23 Z Measurement Machine
24 Mark Detection Machine 24
26 Database
P1, P2 -- Pn Component field
K1, K2 -- Kn Alignment mark
MH, ML Standard mark

[Translation done.]

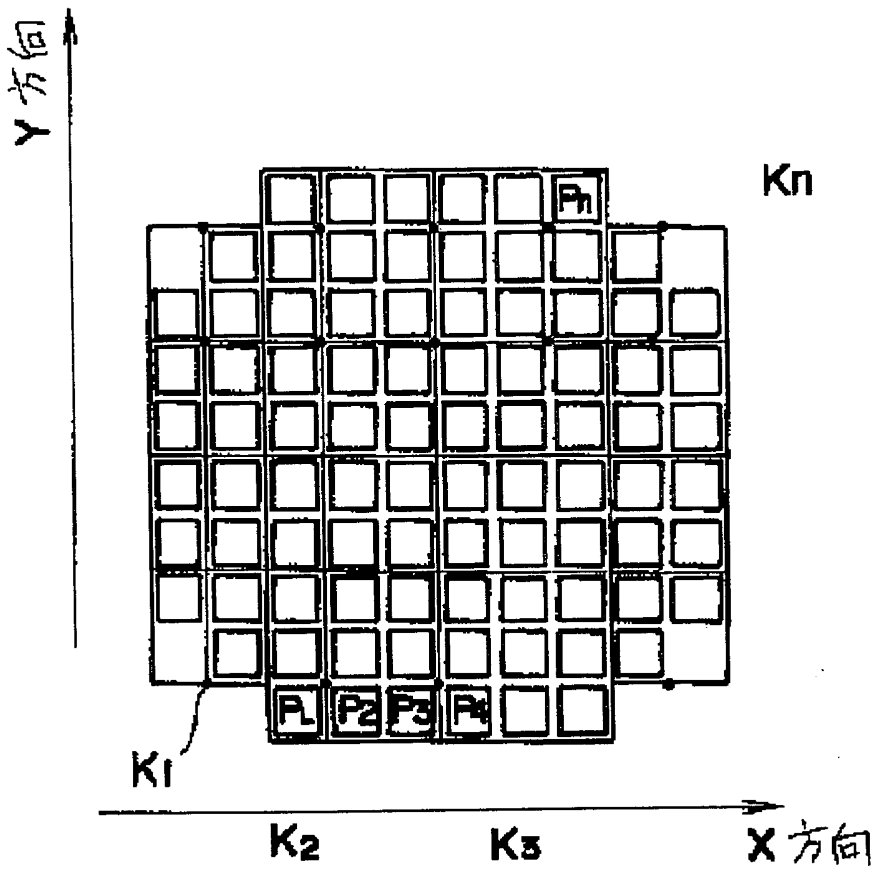
【図 1】


電子線源
成形器
回転レンズ
偏向器
対物レンズ
試料台
成形器制御部
回転レンズ制御部
偏向制御部
対物レンズ制御部
成形信号発生部
偏向信号発生部
試料台制御部
演算部
第2のバッファメモリ
第1のバッファメモリ
制御計算機
描画データ格納部
データベース

【図 2】

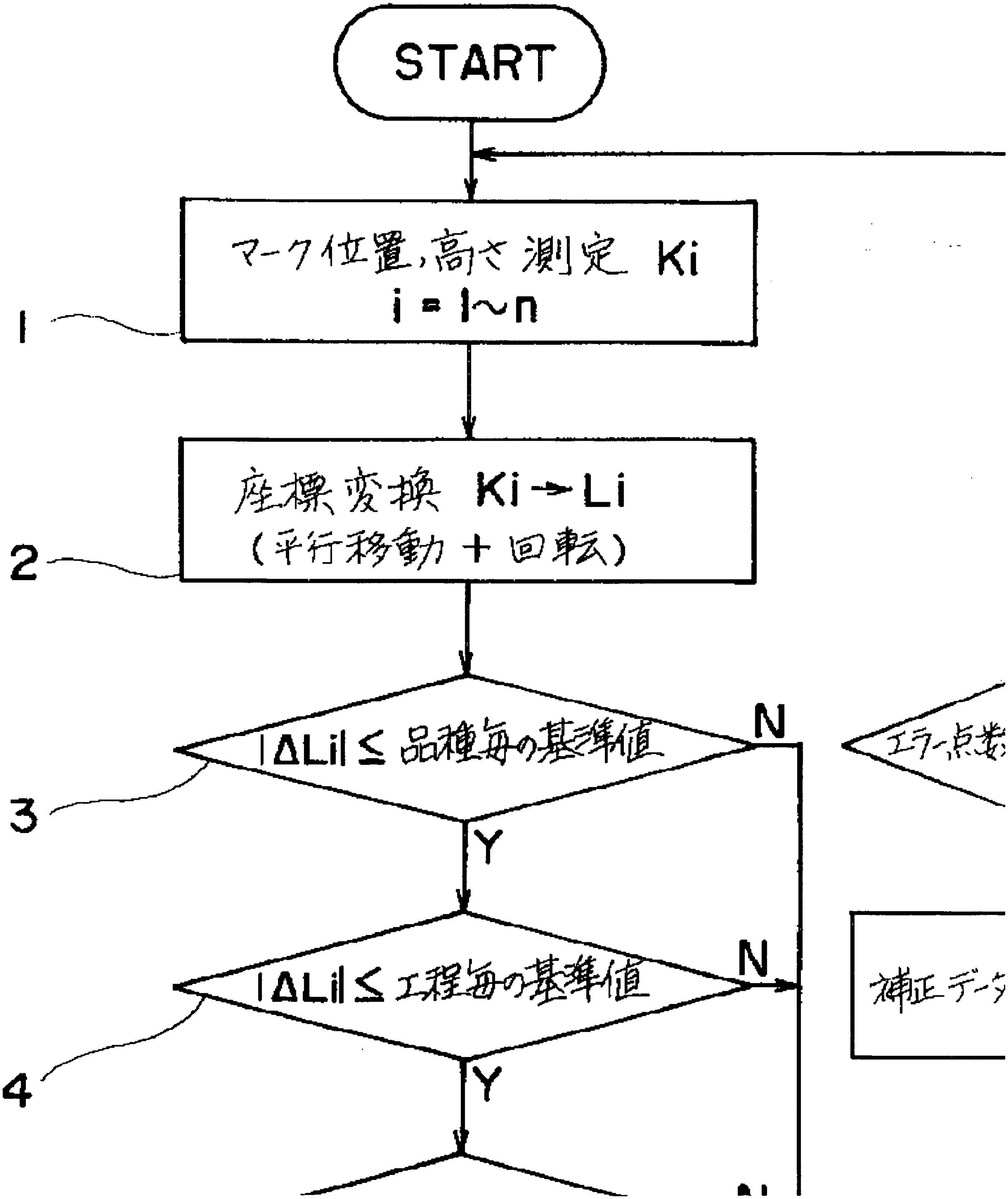


【図 3】

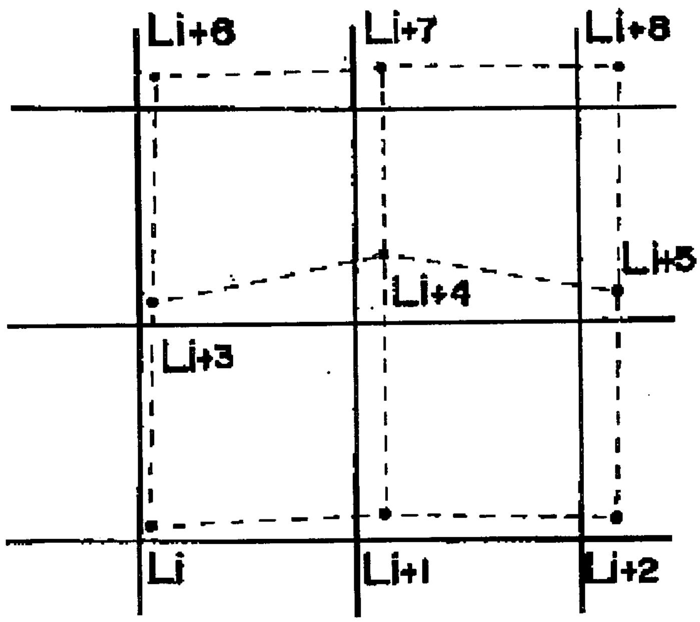


K1～Kn……アライメントマーク
P1～Pn……素子領域

【図 4】

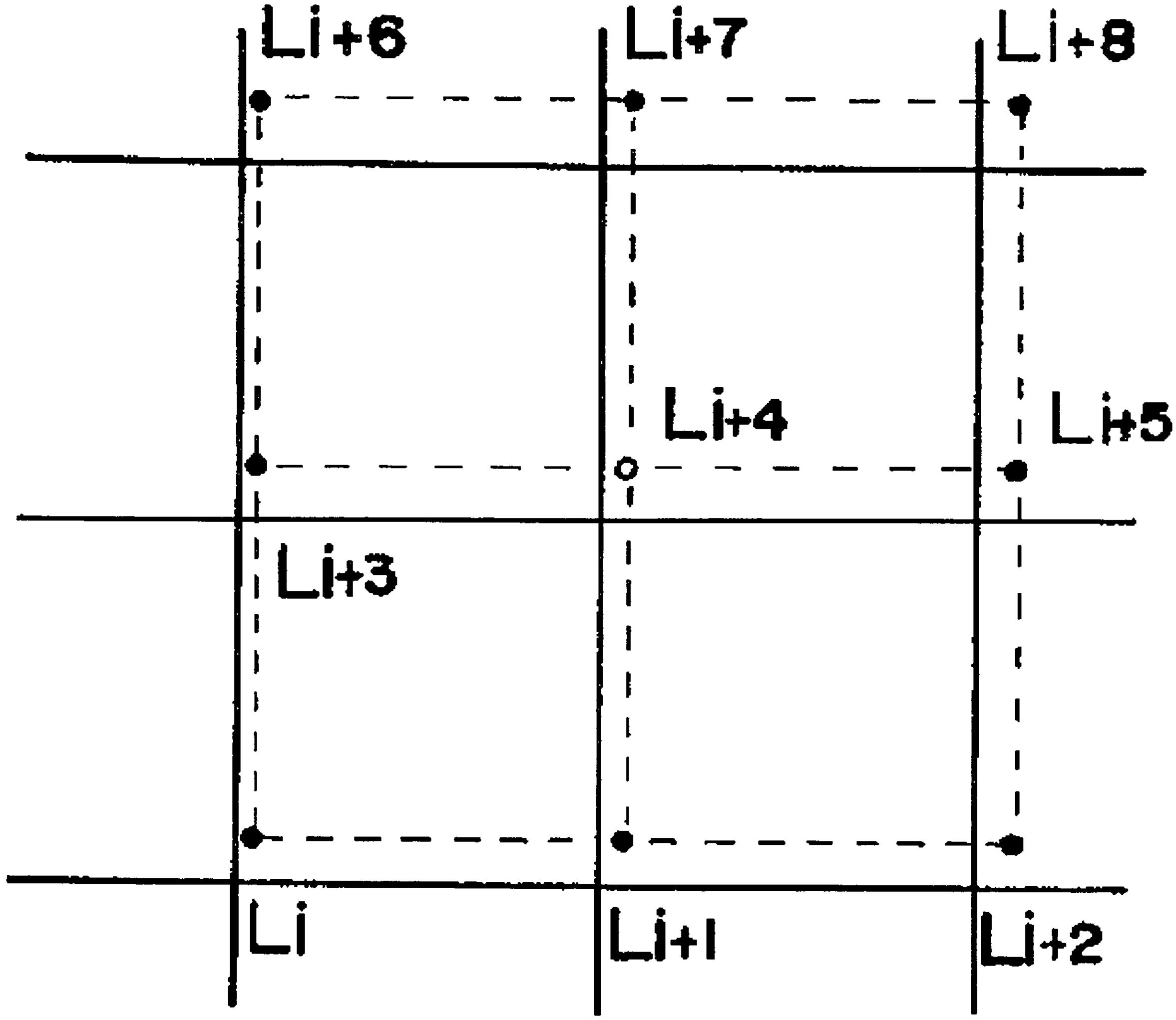

START
マーク位置,高さ測定 Ki
i = 1〜n
1
座標変換 Ki→Li
(平行移動 + 回転)
2
|ΔLi| ≦ 品種毎の基準値
N
Y
3
エラー点数
|ΔLi| ≦ 工程毎の基準値
N
Y
4
補正データ

【図 5 】



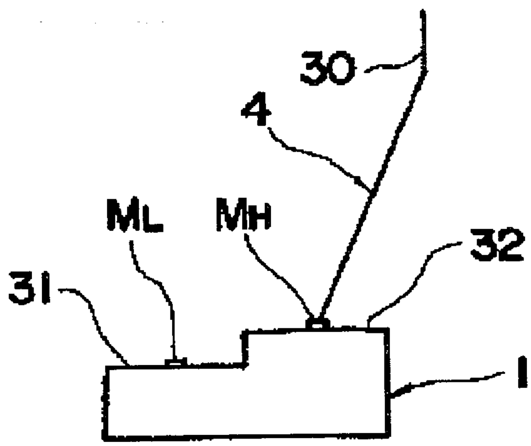
Li+4：マーク検出エラーの場合

【図 6】

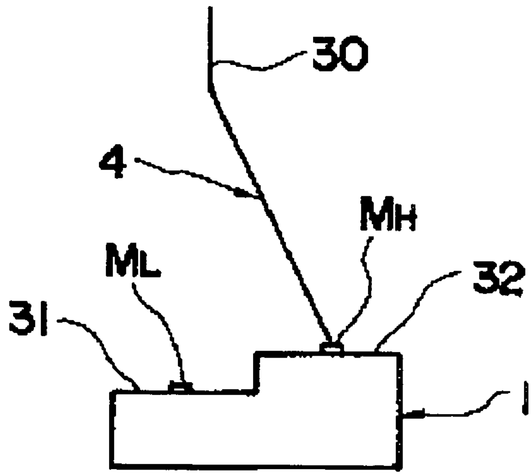


$$Li+4(x\cdot y)=\frac{1}{n-1}\left\{\sum^{n} Li(x\cdot y)-Li+4\,(x\cdot y)\right\}$$

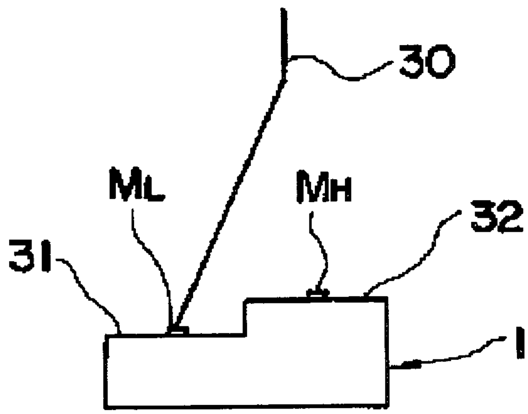
【図　7　】



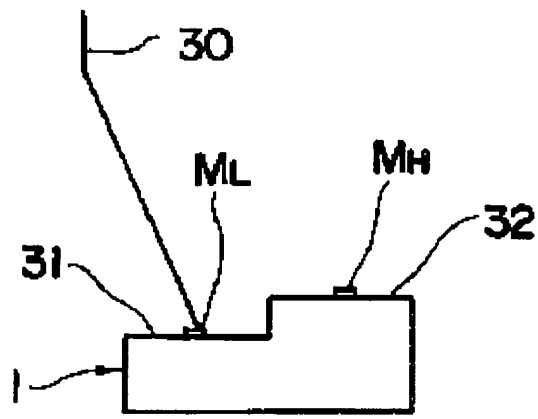
【図 8 】



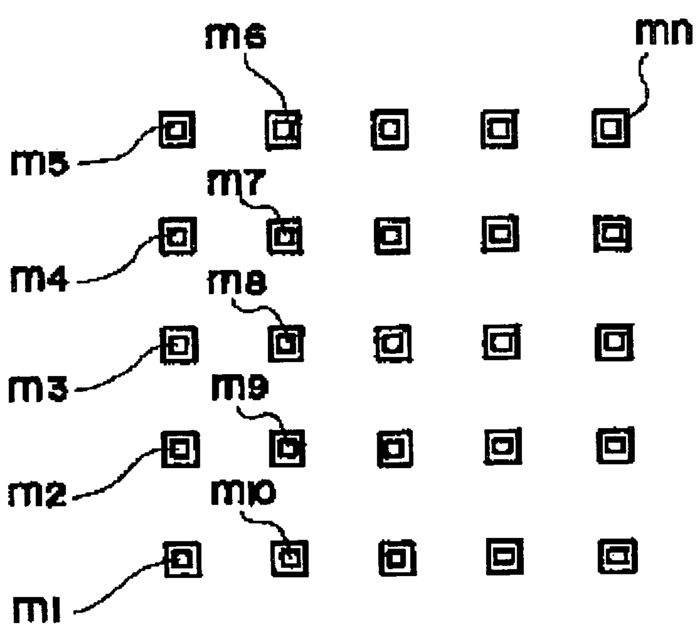
【図 9】



【図10】

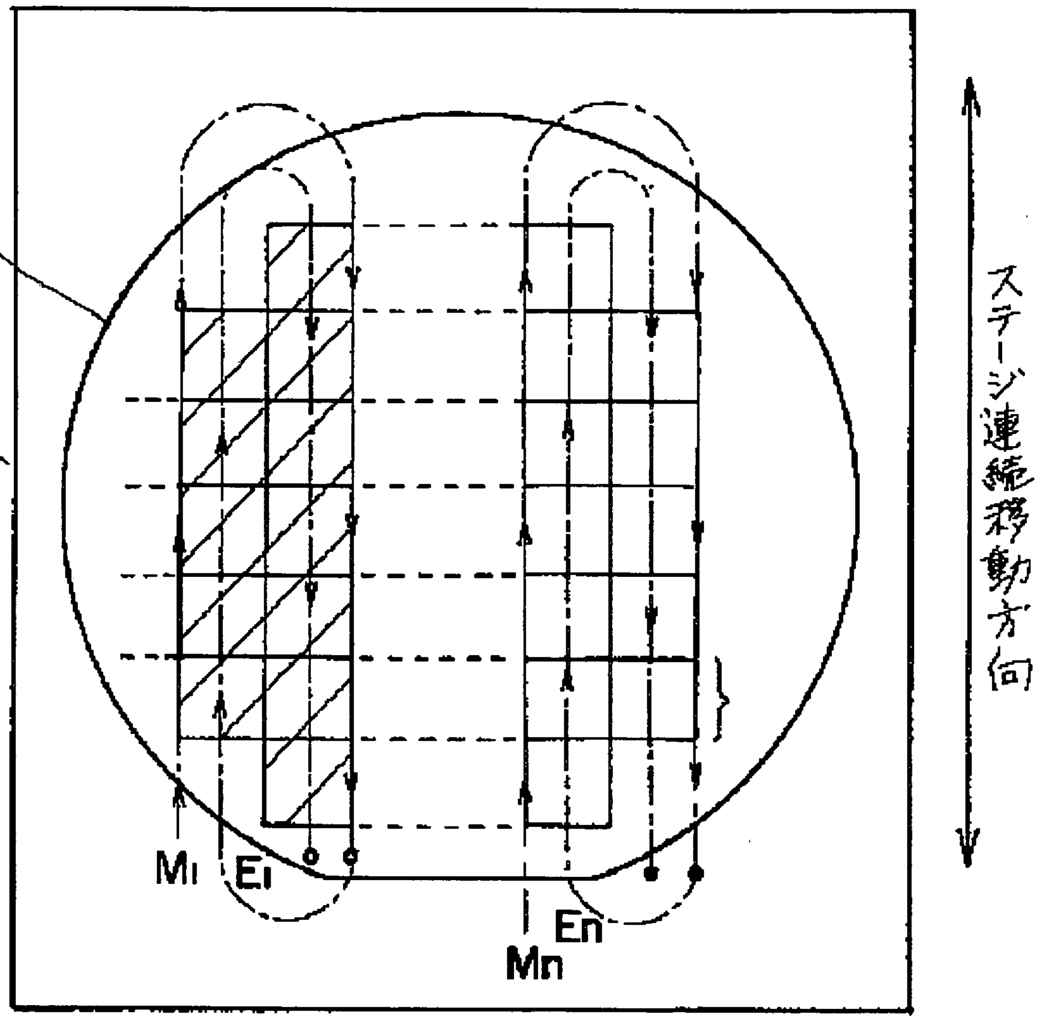


【図 11】



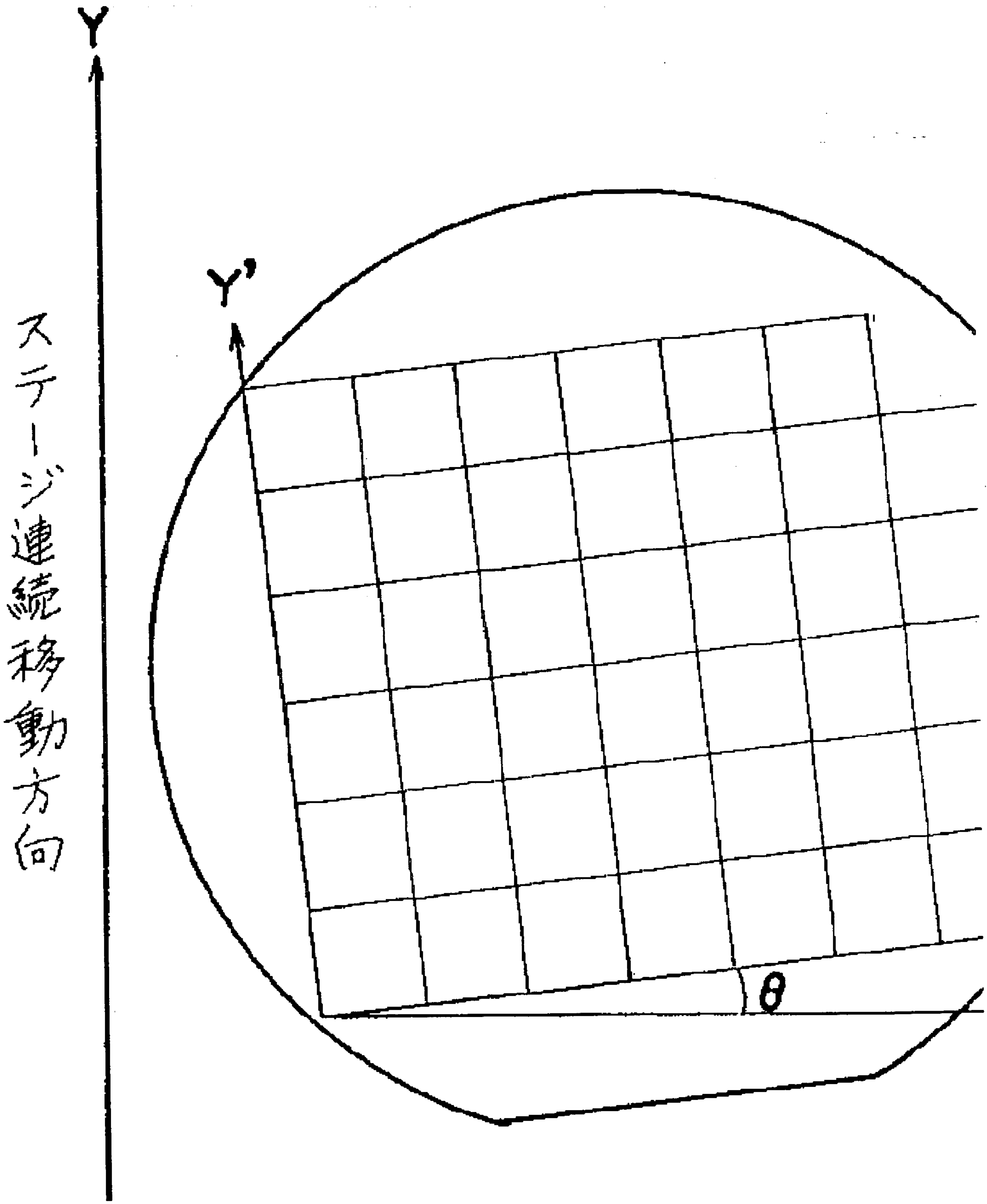
m1～mn…マーク検出位置

【図 12】

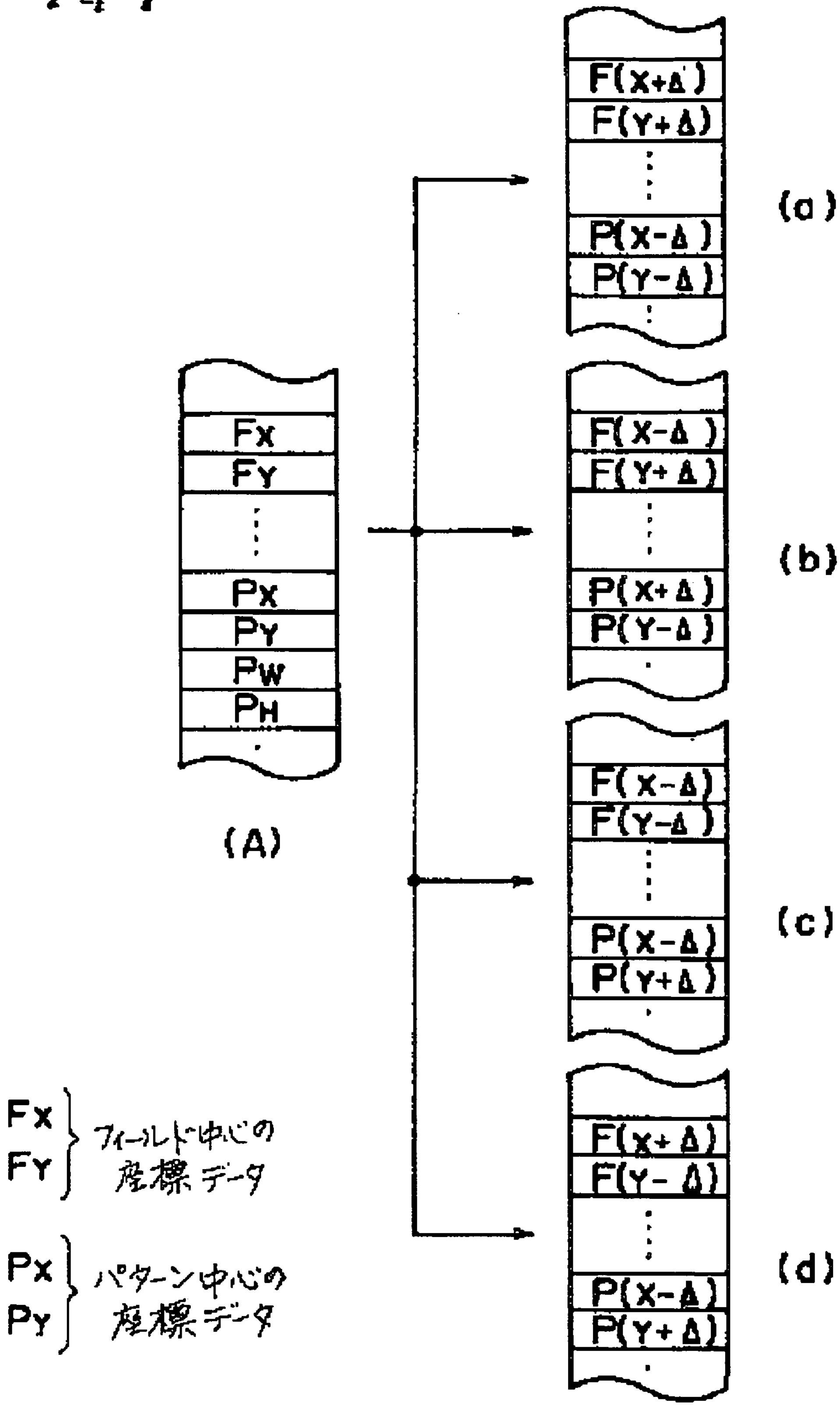


Mi　マーク検出
Ei　パターン描画

【図 13】



【図14】


F(X+Δ)
F(Y+Δ)
P(X−Δ)
P(Y−Δ)
(a)
F(X−Δ)
F(Y+Δ)
P(X+Δ)
P(Y−Δ)
(b)
F(X−Δ)
F(Y−Δ)
P(X−Δ)
P(Y+Δ)
(c)
F(X+Δ)
F(Y−Δ)
P(X−Δ)
P(Y+Δ)
(d)
Fx
Fy
Px
Py
Pw
PH
(A)
Fx Fy フィールド中心の座標データ
Px Py パターン中心の座標データ

【図 15】